


**ENERGY SOLUTIONS**

**Energy Auditor**

Anthony Cox  
[acox@chpc2.org](mailto:acox@chpc2.org)  
 540-230-3432


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**Introduction**  
 Energy Auditor

- ▶ **Energy Auditor**
  - ▶ Weatherization Program Overview
  - ▶ JTA Energy Auditor description
  - ▶ Priority List
  - ▶ Standard Work Specifications (SWS)
  - ▶ Field Guide
  - ▶ JTA – Review
  - ▶ Health & Safety Plan
  - ▶ WPN 22-4 Quality Work Plan

1



**Mission**  
 Introduction and Mission Statement

**Mission of the Weatherization Assistance Program**

To reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children, while ensuring their health and safety

2




**Organization**  
 Introduction and Mission Statement

**Organization: The Team Approach**




3



**Typical Weatherization Job**  
 Introduction and Mission Statement

- Client Intake**
  - Client income eligibility is verified and audit is scheduled
- Initial Site Visit**
  - Data is collected and diagnostic testing is performed by the Energy Auditor to develop a work scope and materials list. Work is scheduled
- Work Scope Implemented**
  - Work that is cost effective is done to the home by the Retrofit Installer Technicians under the guidance of the Crew Leader. Final inspection is scheduled
- Final Site Visit**
  - Work completed is inspected and final diagnostic testing is completed by the Energy Auditor
- Quality Control Inspection & Monitoring**
  - Job documents, processes, work practices and diagnostics are reviewed by the Quality Control Inspector. DOE may also choose the job for monitoring

4



**Energy Auditor Job Scope and Description**

- ▶ An experienced professional who evaluates the health and safety issues, durability, comfort, and energy use of a residential building.
- ▶ Conducts advanced diagnostic tests, gathers and analyzes data, and creates models to draw conclusions and make recommendations to the client for improvements.

5

**Priority Lists**

- ▲ Hawaii requested DOE assistance to review, verify, and approve an updated priority list for Site-Built Single Family, Manufactured, and Small Multifamily housing.
- ▲ Hawaii provided measure details, measure costs, fuel prices, and information on building stock.

6

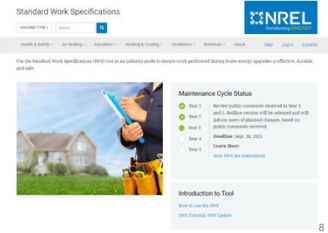
**Priority List Measures**

- ▲ Low-Flow Showerheads & Faucet Aerators
- ▲ CFL or LED Lighting
- ▲ Advanced Power Strip – Tier 2
- ▲ Hybrid Heat Pump or Solar Water Heater
- ▲ Small Room Air Conditioners (6-15,000 Btu/h)
- ▲ Large Room Air Conditioner (18,000 Btu/h)
- ▲ Refrigerator Replacement

7

**Standard Work Specifications (SWS)**

Defines the minimum acceptable outcomes for home energy upgrades installed on single-family, multifamily, and manufactured housing.

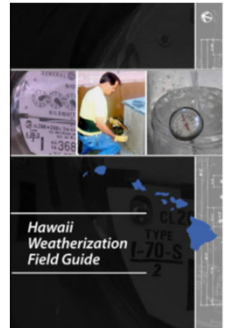


[sws.nrel.gov](http://sws.nrel.gov)

8


**Field Guides**

Provide Grantee-specific comprehensive field standards outlining expectations of work quality and the installation of WAP measures.



9

**Job Task Analysis JTA**



**Single-Family Energy Auditor Job Task Analysis**  
Heather Head and Chuck Kurnik  
National Renewable Energy Laboratory

A Job Task Analysis helps identify the core knowledge areas, critical work functions, and/or skills typically found across a representative sampling of current practitioners.

10

**JTA Domains**

Client Interactions

- ▲ Domain 1: Collection of Information About the Dwelling Unit
- ▲ Domain 2: Diagnostic Testing of the Dwelling Unit
- ▲ Domain 3: Evaluation of the Data to Determine the Scope of Work

11

**The Professional Energy Auditor**

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# Client Interactions

12


12

**Client Interview**

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Client Interactions

- ▲ Assessment begins with meeting and interviewing the client.
- ▲ Follow the ground rules of showing respect, honesty, and understanding.
- ▲ Making the client part of the auditing process often yields very important clues about:
  - Health and Safety
  - Comfort
  - Energy Efficiency



13

13

**Client Interview**

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Client Interactions

**Explain the audit process and discuss retrofit options**

- ▲ Health and safety assessment
- ▲ Shower Heads, Aerators, Lighting, Power Strips
- ▲ Water Heater
- ▲ Room Air Conditioner(s)
- ▲ Refrigerator
- ▲ How the home and their lives will be improved through weatherization

14

14

**Discussion**

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Client Interaction

- ▲ What are some ways that we can prevent client education from turning into client information?
  - What tools are you using currently?
  - What would you like to see done differently?

15

15

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# Skills & Responsibilities

16

16

**Energy Auditor Requirements**

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Skills & Responsibilities

**Possess a working knowledge of:**

- ▲ Department of Energy (DOE) Weatherization Assistance Program regulations and policies
- ▲ Your state's Field Guide and SWS (Standard Work Specifications)
- ▲ Environmental Protection Agency (EPA) guidelines for asbestos, lead, mold, and other health hazards
- ▲ OSHA guidelines for worker safety
- ▲ Safety Data Sheets (SDS)

17

17

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# The Professional Energy Auditor

## Worker Safety

18


18

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WXTV

Worker Safety

[www.wxtvonline.org](http://www.wxtvonline.org)



19

19

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## Lead Safety

Health & Safety Concerns

▶ All work done on pre-1978 homes requires a Certified Lead Safe Renovator *if disturbing;*

- >6 sq.ft. of interior surface
- >20 sq.ft. of exterior surface



CONTRACTORS

### Lead Safety During Renovation

20

20

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## Lead Safety

Health & Safety Concerns



21

21

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## Confined Spaces

Worker Safety



### Permit-Required Confined Spaces



A confined space has limited openings for entry or exit, is large enough for entering and working, and is not designed for continuous worker occupancy. Confined spaces include underground vaults, tanks, storage bins, manholes, pits, silos, underground utility vaults and pipelines. See 29 CFR 1910.146.

Permit-required confined spaces are confined spaces that:

- May contain a hazardous or potentially hazardous atmosphere.
- May contain a material which can engulf an entrant.
- May contain walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant.
- May contain other serious physical hazards such as unguarded machines or exposed live wires.
- Must be identified by the employer who must inform exposed employees of the existence and location of such spaces and their hazards.


22

22

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## SDS Worksheets

Worker Safety



### Hazard Communication Safety Data Sheets

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheets, or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require the SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

Section 1. Identification includes product identifier, manufacturer or distributor name, address, phone number, emergency phone number, recommended use, restrictions on use.

Section 2. Hazard(s) identification includes all hazards regarding the chemical, required label elements.

Section 3. Composition/information on ingredients includes information on chemical ingredients, trade secret claims.

Section 4. First-aid measures includes important symptoms/effects, acute, delayed, required treatment.

Section 5. Fire-fighting measures lists suitable extinguishing techniques, equipment, chemical hazards from fire.

Section 6. Accidental release measures lists emergency procedures, protective equipment, proper methods of containment and cleanup.

Section 7. Handling and storage lists precautions for safe handling and storage, including incompatibilities.

Section 8. Exposure controls/personal protection lists OSHA's Permissible Exposure Limits (PELs), ACGIH Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the SDS, where available as well as appropriate engineering controls, personal protective equipment (PPE).

23

23

**Assessing Building Details**

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# Deferral of Service

24

24

**When you MAY Defer**

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Deferral of Service

- Health & Safety concerns.
- Threatening animals.
- Threatening clients.
- Remodeling.
- Refusal of measures.
- Illegal activities.
- Unusual situations.

WEATHERIZATION ASSISTANCE PROGRAM  
**WEATHERIZATION DEFERRAL NOTICE**

Client: \_\_\_\_\_ Phone: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_

The following problems prevent the installation of Weatherization conservation measures at this time:

Problems with combustion appliances we are unable to correct:  
 Furnace/Boiler  Water Heater  Range/Hot Water  Clothes Dryer  Other: \_\_\_\_\_

Extensive repair of structure or mechanical systems is required that is cost-prohibitive:  
 Structure  Plumbing  Electrical  Heating  Other: \_\_\_\_\_

Sanitation problems are present which could endanger the weatherization crew:  
 Sewage  Other: \_\_\_\_\_

Severe moisture problems are present:  
 Structure  Crawlspace  Attic  Other: \_\_\_\_\_

25

25

**When you MUST Defer**

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Deferral of Service

- Already weatherized with DOE funds.
- Vacant.
- Demolition scheduled.
- Condemned.
- Structural problems.
- Mobile Home with poor supports.
- Client/Owner declines services.

26

26

**May or Must Defer?**


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Deferral of Service

## Unsound Structure?

**Must.**

If the dwelling is structurally unsound, deferral of weatherization is required.



Rotten beam  
Photo Courtesy of The US Department of Energy

27

27

**Deferrals: What To Do About It**

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Skills & Responsibilities

- Inform in writing.
- Include:
  - Reason for deferral.
    - Show pictures.
  - Corrective action.
  - Timeframe.
  - Right to appeal.
- Keep a copy in client file.
  - Include pictures.
- Referrals.

NEVADA DEPARTMENT OF BUSINESS AND INDUSTRY - BUSINESS DIVISION  
WEATHERIZATION DEFERRAL NOTICE

Client: \_\_\_\_\_ Phone: \_\_\_\_\_  
Address: \_\_\_\_\_ City: \_\_\_\_\_

The following problems prevent the installation of Weatherization conservation measures at this time:

Problems with combustion appliances we are unable to correct:  
 Furnace/Boiler  Water Heater  Range/Hot Water  Clothes Dryer  Other: \_\_\_\_\_

Extensive repair of structure or mechanical systems is required that is cost-prohibitive:  
 Structure  Plumbing  Electrical  Heating  Other: \_\_\_\_\_

Sanitation problems are present which could endanger the weatherization crew:  
 Sewage  Other: \_\_\_\_\_

Severe moisture problems are present:  
 Structure  Crawlspace  Attic  Other: \_\_\_\_\_

Unsound structure problems:  
 Foundation  Floor  Roof  Other: \_\_\_\_\_

Unsound mobile home supports:  
 Support Posts  Other: \_\_\_\_\_

Other problems: \_\_\_\_\_

If these problems can be satisfactorily corrected within 90 days from the date of this notification, then we will continue work on this project. If the problems are not corrected within this time period, we will assume that you are unable to make the necessary corrections and your file will be closed.

Please contact our office at the number below to determine if we can assist in referring you to other programs or agencies that report that all problems have been corrected.

Agency: \_\_\_\_\_ Phone: \_\_\_\_\_  
Weatherization Agency: \_\_\_\_\_ Date: \_\_\_\_\_  
Weatherization Agency: \_\_\_\_\_ Date: \_\_\_\_\_

28

28

**Client Signatures**

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Skills & Responsibilities

The Auditor must ensure that all relevant documents are signed by the client

Note: Exact documents required are specific to a given agency and/or state

29

29

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## Crew & Contractor Liaison

Skills & Responsibilities



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30

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## Energy Auditor Single Family

DOMAIN 1 (page 8)

### Collection of Information About the Building

JTA Domain 1, Tasks 1-13

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31

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## Ranch Homes

Building Styles



Courtesy of Building Performance Engineering

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32

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## Manufactured Housing

Building Styles



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33

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## Diagnostic Testing

# Indoor Air Quality Assessment

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34

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## Carbon Monoxide

Indoor Air Quality Assessment

CO Action Levels for Ambient Measurements	
≥70ppm	Immediately terminate the inspection and notify the homeowner/occupant of the need for all building occupants to evacuate the building. The auditor shall immediately leave the building and the appropriate emergency services shall be notified from outside the home.
Between 36 – 69ppm	Advise the homeowner/occupant that elevated levels of ambient CO have been detected. Windows and doors shall be opened. The auditor shall recommend that all possible sources of CO be turned off immediately. Where it appears that the source of CO is a permanently installed appliance, the auditor shall recommend that the appliance be turned off and the homeowner/occupant shall be advised to contact a qualified professional.
Between 9-35ppm	Advise the homeowner/occupant that CO has been detected and recommend that all possible sources of CO be checked and windows and doors opened. Where it appears that the source of CO is a permanently installed appliance, the homeowner/occupant shall be advised to contact a qualified professional.

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35



**Radon**  
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Indoor Air Quality Assessment

EPA Map of Radon Zones

Zone 1  
Zone 2  
Zone 3

Interactive EPA Radon Zones Map

36

36

**Moisture**  
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Health & Safety Concerns

**Auditors should determine underlying causes of moisture damage.**

Damage from roof leaks

Mold on walls indicates serious moisture issues

37

37

**Mold Remediation or Deferral?**  
ENERGY SOLUTIONS  
Indoor Air Quality Assessment

Mold cannot cover an area greater than **10 ft<sup>2</sup>** if work is to continue using WAP funds

38

38

**Vermiculite**  
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Building Insulation

39

39

**Assessing Building Details**  
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**Health & Safety Concerns**

40

40

**Electrical Hazards**  
ENERGY SOLUTIONS  
Health & Safety Concerns

- ▶ Inspect Electrical Panels and Service Entrance
- ▶ Protect fixtures electrical junctions with code approved covers.
- ▶ Note Type and Condition of Wiring
- ▶ Knob-and-tube issues
  - Insulating around knob-and-tube can cause it to overheat and become a fire hazard
- ▶ A voltage drop over 5% may indicate undersized wiring, improper slices, and other dangerous point loads due to bad connections.

41

41

## Electrical Hazards

Health & Safety Concerns

- ▶ Note the locations of these and any other electrical hazards:
  - ▶ Knob-and-tube wiring.
  - ▶ Open wire splices
  - ▶ Uncovered junction boxes.
  - ▶ Frayed wire, etc.

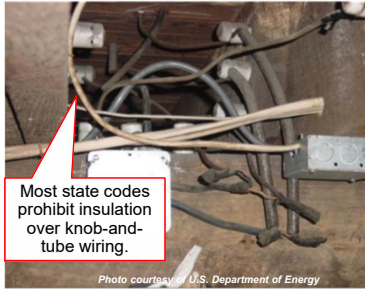


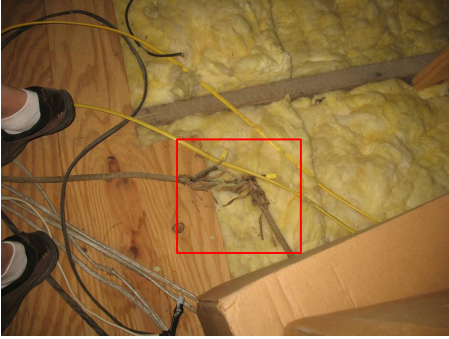
Photo courtesy of U.S. Department of Energy

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42

42

## Exposed Electrical Connections

Health & Safety Concerns



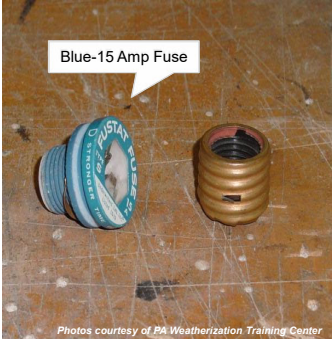
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43

43

## S-Type Fuses

Health & Safety Concerns

- ▶ S-Type Fuses
  - ▶ Tamper-proof
  - ▶ Barbed shell screws into fuse panel
  - ▶ Only proper fuse will fit into shell
  - ▶ Color coded




Photos courtesy of PA Weatherization Training Center

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44


44

## Circuit Testing & Tracing


Health & Safety Concerns



Live wire tester



Circuit tracer determines which fuse/breaker controls which circuit



Tells auditor percent overload on circuit, among other outputs



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45

45

## Smoke & Carbon Monoxide Monitors

Health & Safety Concerns

- ▶ Should be installed as per 2012 IRC, or local codes, if different
- ▶ Recommended to have one CO detector on every floor, for homes with combustion appliances
- ▶ Smoke detectors usually placed one per bedroom; one in every shared hallway; and at least one on each floor, including unconditioned basements, if there are plugs in the basement
- ▶ Test that all alarms work and that they are not more than 10 years old. A new battery or a new unit may be needed.



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46

46

## Clothes Dryer Venting

Health & Safety Concerns

- ▶ Dryer vents must terminate outside, not in unconditioned spaces nor in the home
- ▶ Venting material must be rigid or semi-rigid sheet metal
- ▶ Vent pipe that passes through unconditioned space must be insulated
- ▶ Lint filters and air intakes should be kept clean and free of obstructions
- ▶ Pipe should have the shortest run, and fewest bends, possible

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47

47




**Unvented Space Heaters**  
Health & Safety Concerns



48

**Temperature & Pressure Relief Valves**  
Health & Safety Concerns



Common to all types of tank water heaters, regardless of fuel type.

Relief pipe should terminate not more than 6" from the floor

[Myth Busters Video](#)

49

48

49

**Assessing Building Details**

**Baseload Energy Use**

50

**Baseload Defined**  
Baseload Energy Use

- ▲ **Baseload:**
  - ▶ The energy used by electric or gas appliances in a home that is not used for space conditioning, thus not a seasonal load
- ▲ **Typical Measures:**
  - ▶ Low-flow Fixtures
  - ▶ Lighting Retrofits
  - ▶ Advanced Power Strips –Tier 2
  - ▶ Refrigerator Replacement
  - ▶ Water Heater Modification

51

50

51

**Occupant Impacts**  
Baseload Energy Use


**Baseload use affected by:**

- # of occupants.
- Size and efficiency of appliances (non-space conditioning only)
- Habits of occupants.

▲ Client education is key to effectively reducing base-load energy use.

52

**Utility Bill Analysis**  
Determining Energy Consumption



**Bill Analysis**  
Review previous 12 months.

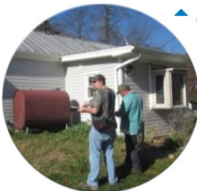
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52

53

**Site Survey Analysis**  
ENERGY SOLUTIONS  
Baseload Energy Use

- Account for typical consumption.
  - Where does all the juice go?
- Build a consumption table based on:
  - Client interviews.
  - Known and guesstimated wattages.
- Hint* – Identify the 5 biggest users.






54

54

**Water Heater Strategies to Consider**  
ENERGY SOLUTIONS  
Baseload Reduction Strategies

- Adjust set temperature.
- Insulate tank
- Insulate first 6 feet of pipes.
  - Maintain clearances from flue pipes.
- Replacement
  - Heat Pump or Solar
- Reduce hot water use.
  - Low-flow showerheads
  - Faucet aerators

55

55

**Test DHW Temperature**  
ENERGY SOLUTIONS  
Baseload Energy Use

- Mark original position of dial
- Verify water temperature
- Set back to 120° F
- Adjust as needed




Photo Courtesy of US Department of Energy

56

56


**Measuring Showerhead Flow Rates**  
ENERGY SOLUTIONS  
Baseload Energy Use

Showerhead flow rates need to be collected if replacement is to be considered

- Flow rates are often stamped on showerhead neck
- Testing can be done by timing the flow into a graduated container. Record how many seconds it takes to fill to a specific volume, then:

**Fill 1 gallon container:**  
Gallons per minute (GPM) = 60 / result (sec)

**Fill 4 cup container:**  
Gallons per minute (GPM) = 15 / result (sec)





57

57

**Water Saving Measures**  
ENERGY SOLUTIONS  
Baseload Reduction Strategies

- Low-flow Showerheads (1.75 GPM or less)
- Sink Aerators (1.2 GPM) or less
- Repair water leaks





58

58

**Lighting Audit**  
ENERGY SOLUTIONS  
Baseload Energy Use

- Data to Collect:
  - How many incandescent bulbs are in use in the home?
  - Record the wattage of the bulbs
  - How many hours per day are they used?
  - Permanent fixtures only – lamps, vanities, etc.



59

59

### Lighting Comparison

Comparisons between Traditional Incandescents, Halogen Incandescents, CFLs, and LEDs

	60W Traditional Incandescent	43W Energy-Saving Incandescent	15W CFL		12W LED	
			60W Traditional	43W Halogen	60W Traditional	43W Halogen
Energy & Saved (%)	-	-25%	-75%	-65%	-75%-80%	-72%
Annual Energy Cost*	\$4.80	\$3.50	\$1.20		\$1.00	
Bulb Life	1000 hours	1000 to 3000 hours	10,000 hours		25,000 hours	

60

### Lighting

Baseload Reduction Strategies

- LEDs and CFLs save energy by producing more light (output) per watt of energy used.
- The light output is measured in **lumens**.

Incandescent (watts)	Minimum Light Output (lumens)
40	450
60	800
75	1,100
100	1,600
150	2,600

61

### Lighting Calculation

Baseload Reduction Strategies

**To calculate the energy saved through lighting retrofits we need:**

- Number of bulbs being replaced. (4)
- Wattage of existing bulbs. (60)
- Wattage of replacement bulbs. (9)
- Usage (hrs/day). (6)

$$\frac{4 \times (60-9)}{1,000 \text{ Watts/KW}} \times 6 \text{ Hours/day} \times 365 \text{ Days/year}$$

$$= 447 \text{ KWh/yr} \times \$0.43/\text{KWh} = \$192.21 \text{ savings a year}$$

Red Calc


62

### Refrigerator Replacement Savings

Baseload Reduction Strategies

- Replacement includes removal and decommissioning of old unit, must be included in cost for SIR calculations.
- Only when cost-effective, SIR ≥ 1.
- Based on metering and/or refrigerator database.

**Refer to your state WAP standards for eligibility**



63



### Diagnostic Testing

# Electric Appliance Testing

64

### Measuring Actual Electrical Usage

Electric Appliance Testing

**So easy to use!**  
 Plug in the appliance you want to test at the start of your inspection.  
 Don't forget to collect it at the end!

65

**ENERGY SOLUTIONS** Metering Duration Electric Appliance Testing

- ▶ Debate over how long a refrigerator must be metered to accurately estimate annual energy use.
  - ▶ 1-hour tests accurate within  $\pm 10\%$  only 18 times out of 100.
  - ▶ 3-hour tests increase  $\pm 10\%$  accuracy to 90 times out of 100.
  - ▶ Currently recommending at least 2 hours.

FOR MORE INFORMATION:  
The **Refrigerator Info Toolkit** on [www.waptac.org](http://www.waptac.org)

66

66

**ENERGY SOLUTIONS** Not Able To Meter? Electric Appliance Testing


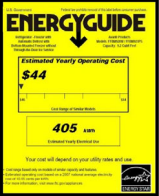
- ▶ It is not always possible to meter the refrigerator.
  - ▶ Cannot move fridge without damaging floor or water lines.
  - ▶ Difficult access due to cabinets, furniture, stove, etc.
  - ▶ Receptacle suspect.
- ▶ When metering is not possible, use database for energy use of existing refrigerators.

67

67

**ENERGY SOLUTIONS** Appliance Replacement Baseload Energy Use

- ▶ It is often more cost-effective to purchase and operate a new **Energy Star** appliance than to continue operating an older one, especially one that is more than 10 years old.
- ▶ Savings are often in the range of 40% (or more) as compared to a typical older unit
- ▶ Only an SIR calculation based on metered or predicted energy usage data can assess the real value of appliance replacement

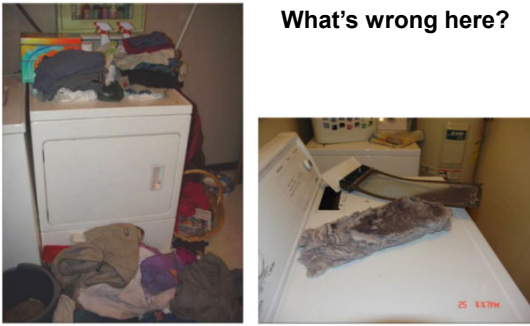



68

68

**ENERGY SOLUTIONS** Client lifestyle Baseload Energy Use

What's wrong here?



69

69

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**Energy Auditor Single Family**

Domain 2 (page 14)

**Diagnostic Testing of the Dwelling Unit**

JTA Domain II, Tasks 1-6

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70

70

**ENERGY SOLUTIONS** Diagnostic Testing

**Setting Up For Diagnostic Testing**

71

71


**Perform Live Diagnostic Testing**  
Interpreting Infrared

- ▲ Gas Sniffing
- ▲ Worst Case Depressurization
- ▲ Combustion Testing

72

**Propane (LPG)**


- ▲ Heavier than air
- ▲ Smaller orifice
- ▲ Higher delivery pressure
- ▲ Measured in gallons
- ▲ Privately sold in rural areas – stored on site



73

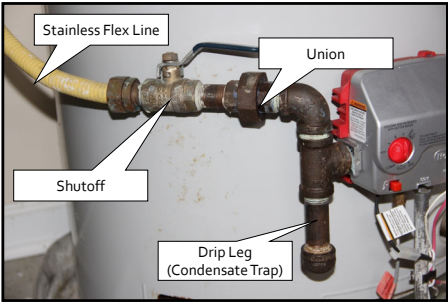
**Propane (LPG)**

Propane tanks can be installed above ground or buried. You can tell the presence of a buried tank by the lid left exposed for filling.




74

**Gas Line Components**




75

**Gas Leak Detection**



Has audible tick, but no display  
❌ (No longer compliant)



Has audible tick, digital display, and can provide an alarm when gas concentrations exceed 10% LEL  
✓ (Compliant with 1200 Standards)

76

**Gas Leak Detection**

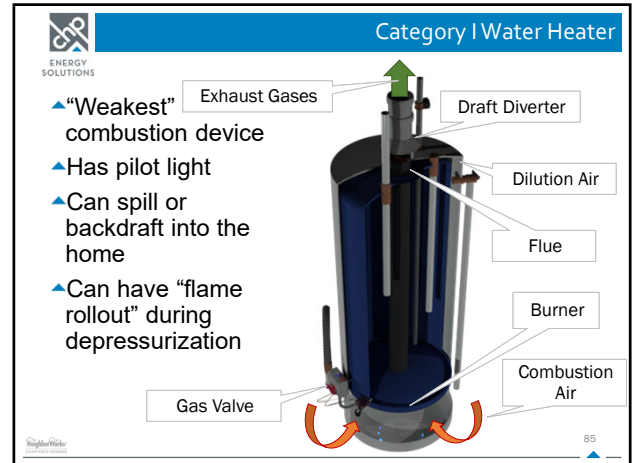
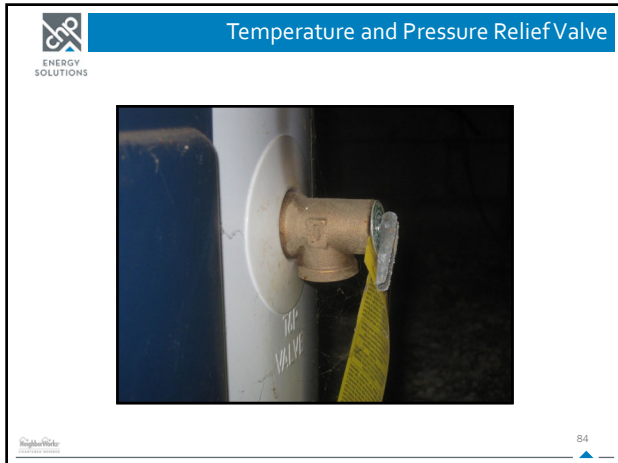
Inspection – Perform Fuel Leak Inspection

- ▲ **What is the source?**
  - Storage tank (LP) or gas meter (NG)
- ▲ **Gas pipe material?**
  - Steel? If flex line, replace if manufactured pre-1973.
- ▲ **Electronic leak detector**
  - Sniff all accessible gas lines. No more than 1" per second, 360° around every joint, fitting, union, or connection.
- ▲ **Leak detection solution**
  - Surveyors tape for flagging leaks

77

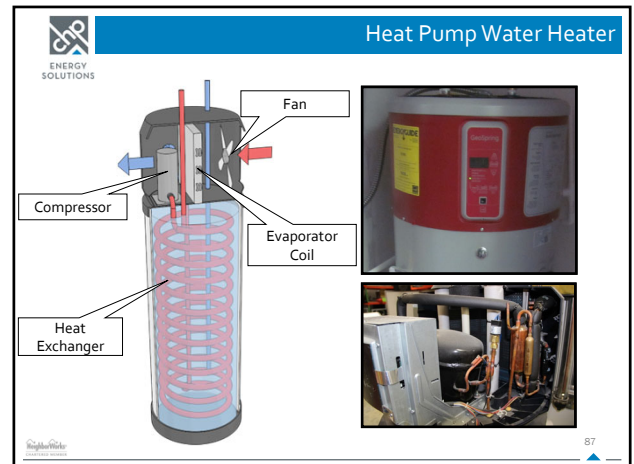
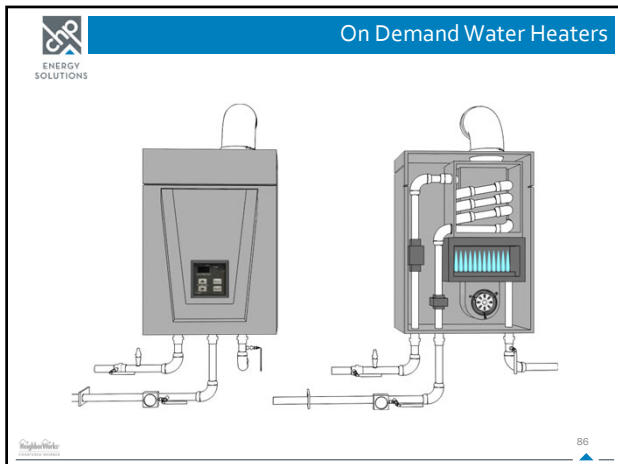






84

85



86

87

**Heat Pump Water Heater Calculator**

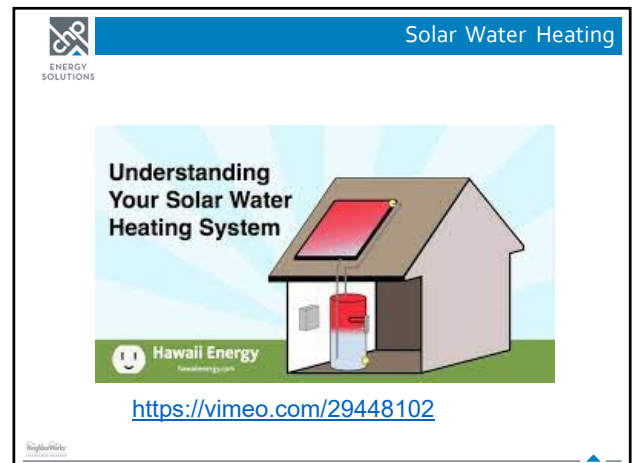
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**Heat Pump Water Heater Calculations**

Number of people in household	4
Storage Size	50
Hot Water Use per day	55
UEF - ENERGY STAR	3.45
UEF - Standard	0.95
ENERGY STAR Annual Energy Use	1,399
Standard Product Annual Energy Use	5,106
Annual energy savings (based on family size)	3,708
Annual % Savings	73%
Annual \$ savings	\$370.76
Payback period	1.8
Lifetime savings	\$3,027.26
Annual GHG Savings (lbs)	5,780
Lifetime GHG Savings (lbs)	75,142

Type	Energy Factor		Daily Hot Water Draw (Gal.)	Size Assumed (Gallons)
	ES V3.0	2015 Federal standard		
Electric Storage Water Hot Water (≤ 55 gallons)	2.00	0.95	Low	40
Electric Storage Water Hot Water (≤ 55 gallons)	2.00	0.95	Medium	50

88



88

89

## Solar Water Heater Calculator

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		Scenario 1: Calculate solar fraction using solar resource data.	Scenario 2: Input desired solar fraction.
			Solar fraction=fraction of load met by solar <b>30%</b>
		English Units	English Units
<b>Hot Water Use Information</b>			
$Q_{\text{daily}}$	Daily Hot Water Use (volume/day)	70.00 gallons/day	1000.00 gallons/day
$T_{\text{cold}}$	Cold Incoming Water Temperature	60.00 F	60.00 F
$T_{\text{hot}}$	Hot Water Delivery Temperature	140.00 F	140.00 F
$Q_{\text{load}}$	Equation: Building Hot Water Energy Requirement	0.47 therms/day	6.66 therms/day
$f_{\text{fuel}}$	Cost of Electricity or Fuel (\$/therm) Used for Water Heating	5.28 \$/therm	5.28 \$/therm
$\eta_{\text{heating}}$	Thermal Efficiency of Conventional Heating System	0.93	0.93
<b>Updated Design Values:</b> <i>These are reasonable default values for the efficiency of the solar water heater (annual average) and the fraction of solar heat that can be used. These inputs may be changed.</i>			

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90

## Solar Water Heater Inspection Form

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### Form 1 - Residential System Verification Form

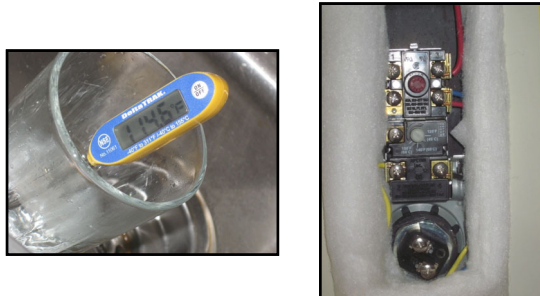
Customer: \_\_\_\_\_ Work Order #: \_\_\_\_\_  
 Contractor: \_\_\_\_\_ Centralized Dual System: Yes / No  
 Phone: \_\_\_\_\_ Collector Access: One Story / Two Story / Other  
 Contact: \_\_\_\_\_ Tank Access: Locked / Unlocked  
 Subcontractor(s) Used: Yes / No If YES, Name & Lic. #: \_\_\_\_\_  
 Location of Installation: Oahu / Molokai / Lanai / Maui / Hawaii

SYSTEM DATA		Accepted	Denied
1	Installation Reason	Burnout / Retrofit	
2	Previous Water Heater Type	Electric / Heat Pump / Solar / None	
3	System Type	Active / Passive	
4	Neighborhood / Community		
5	Sunshine Zone	300 350 400 450 480 500 550	
6	Collector Manufacturer		
7	Collector Model No.		
8	Collector Size	3' x 7' 3' x 8' 4' x 8' 4' x 8' 4' x 10'	
9	Absorber Coating	chrome / paint	
10	Collector Orientation	degrees (true)	
11	Collector Orientation Factor	% derating	
12	Collector Mounting Method	flush / side tilt / end tilt	
13	Collector Tilt	degrees	
14	Collector Tilt Factor	% derating	
15	Actual Hot Water Storage	gallons	

91

## Measuring and Adjusting Temperature

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92

## Manufactured Housing Water Heaters

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Some manufactured houses can have water heaters located in an outdoor closet.

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93

## Chimney Liner Installation

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94

## Introduction to CAZ Combustion safety

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95

## Combustion Appliance Zone

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- The Combustion Appliance Zone (CAZ) is simply the area where the combustion occurs. It could be the attic, garage, basement, crawlspace, mechanical room or the whole house.
- BPI Combustion Protocols address space heaters, boilers, furnaces, water heaters, wood stoves, pellet stoves, direct vent gas logs, and unvented heaters.
- Each CAZ gets its own individual test!**

96

## Worst Case CAZ Depressurization Worksheet

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97

## Worst Case CAZ Depressurization Worksheet

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98

## Worst Case CAZ Depressurization Worksheet

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If **over 70 ppm** of Carbon Monoxide is detected inside, evacuate the house, and ventilate it until CO levels have dropped before re-entering to identify the problem.

99

## Worst Case CAZ Depressurization Worksheet

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100

## Worst Case CAZ Depressurization Worksheet

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CO Thresholds for Fossil-Fuel Fired Appliances	
Appliance	CO Threshold
Central Furnace (all categories)	400 ppm air free
Boiler	400 ppm air free
Floor Furnace	400 ppm air free
Gravity Furnace	400 ppm air free
Wall Furnace (BIV)	200 ppm air free
Wall Furnace (Direct Vent)	400 ppm air free
Vented Room Heater	200 ppm air free
Unvented Room Heater	200 ppm air free
Water Heater	200 ppm air free
Oven/Broiler	225 ppm as measured
Clothes Dryer	400 ppm air free
Refrigerator	25 ppm as measured
Gas Log (gas fireplace)	25 ppm as measured in vent
Gas Log (installed in a wood burning fireplace)	400 ppm air free in firebox

**CO Action Levels for Appliance Measurements**

101

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## Making and Sealing Test Ports

Bolts for B-Vent      Caps for Single Wall

High Temp RTV for Airtight Seal

102

102

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## Gas Oven Testing

The oven vent is typically around the center of the back of the range top

103

103

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## Gas Oven Testing

### CO Thresholds for Fossil-Fuel Fired Appliances

Appliance	CO Threshold
Central Furnace (all categories)	400 ppm air free
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**CO Action Levels for Appliance Measurements**

104

104

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## Energy Auditor Single Family

### Domain 3 (page 16)

### Evaluating The Data

JTA Domain III, Tasks 1-11

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105

105

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## Evaluating The Data

# Cost Effectiveness

106

106

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## Elements of Cost-Effectiveness

Cost Effectiveness

- ▶ Cost-effectiveness is dependent upon several variables:
  - ▶ Initial cost of energy conservation measure
  - ▶ Annual savings derived from measure
  - ▶ Life expectancy of measure

107

107



## Savings to Investment Ratio

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How to calculate Savings-to-investment ratio

$$\frac{\text{Measure savings per year} \times \text{Expected life of measure}}{\text{Cost of Measure}}$$

**SIR must be 1.0 or greater, otherwise the savings will never equal the initial investment**

108

108

## Evaluating The Data

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Generate the Work Order

109

109

## Understanding ECMs, IRMs & H&S

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Index	Recommended Measure	Components	Measure Savings (\$/yr)	Measure Cost (\$)	Measure SIR	Cumulative Cost (\$)	Cumulative SIR
1	Fix Leaks		153	153	1.0	153	1.0
2	Weather Stripping		7	307	3.3	412	6.2
3	Weather Stripping		137	1368	9.9	1950	9.9
4	User Spec Ceiling R	R9 - 1	158	144	17.4	2058	18
5	User Spec Ceiling R	C8-1	215	245	13.9	2291	3.9
6	User Spec Ceiling R	A4	147	152	12.9	2451	3.9
11	Lighting Controls	LC	172	185	17.3	2653	4.9
12	Weather Insulation	K10-1	157	530	4.7	3450	4.9
13	Flooring R-20	F-140R1-2	206	1420	2.8	4928	4.2
14	Wall Insulation	W1.5, W1.4, A101, A10.4, A101 G, W1.2, A101.4	235	1307	2.7	6199	3.9
16	Energy Controls		120	100	2.2	6259	3.9
17	CO Monitor in kitchen	Smoke Detector in kitchen	0	0	0.0	6475	0.0

**Health & Safety Items**

- Do not have any bearing on home energy use but are required to ensure client well being

**Incidental Repair Measures**

- Intended to protect and preserve ECMs
- Tied to individual ECM

**Energy Conservation Measures**

- Specifically intended for energy reduction

110

110

## Work Orders & Other Reports

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111

111

## Materials List

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112

112

## Health and Safety Plan & Quality Work Plan

Weatherization Grantee Health and Safety (H&S) Plan- Optional Template  
State of Hawaii Department of Labor and Industrial Relations – Office of Community Services

**Department of Energy**  
Washington, DC 20585

WEATHERIZATION PROGRAM NOTICE 22-4  
EFFECTIVE DATE: December 13, 2021

SUBJECT: Quality Work Plan Requirement Update  
INTENDED AUDIENCE: WAP Grantee Program Managers, WAP Subgrantee Managers

113

113