RE: Installation Standards/Field Guide Approval

The Department of Energy (DOE) has completed the technical review of Guam’s Installation Standards/Field Guides pertaining to Site-Built Single-Family Housing, Manufactured Housing, and Small Multifamily Housing for the Weatherization Assistance Program (WAP).

Based on this review, and Grantee compliance with the notes below, Guam’s Installation Standards/Field Guides are approved for use in the WAP as outlined in Table 1.

<table>
<thead>
<tr>
<th>Installation Standards/Field Guide Type</th>
<th>Approval Expires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site-Built Single-Family Housing</td>
<td>3/4/2025</td>
</tr>
<tr>
<td>Manufactured Housing</td>
<td>3/4/2025</td>
</tr>
<tr>
<td>Small Multifamily Housing</td>
<td>3/4/2025</td>
</tr>
</tbody>
</table>

This review process is comprised of a sampling of the content submitted to DOE for alignment with the Standard Work Specifications (SWS) and overall accuracy. It is the Grantee’s responsibility to ensure that all content aligns with the SWS and that any intentional variations from the SWS are approved by DOE via signature on a Variance Request Form for each approval cycle.

5/7/21

Department of Energy WAP Program Manager

Notes: Approval date aligned with Priority List expiration date (3/4/2025) per Guam’s request.
GUAM WEATHERIZATION FIELD GUIDE

Expires March 4, 2025
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Section 1: Smoke Alarm Battery Operated and Carbon Monoxide Alarm Battery Operated

Smoke Alarm Battery Operated

**Recommended materials:** Battery Operated Smoke Alarm
**Tools Required:** pliers, flathead screwdriver, Phillips screwdriver (for enclosed fixtures)
**Standards:** Select battery-operated smoke alarms that are listed and labeled in accordance with UL 217 and have sealed, non-replaceable, 10-year batteries. Battery operated alarms will be installed in accordance with manufacturer specifications. Provide occupants the manufacturer’s written user’s manuals. See appendix smoke alarm selection guide for smoke alarm battery operated selection tips.
**Reference:** SWS number 2.0101.2 [https://sws.nrel.gov/spec/201012](https://sws.nrel.gov/spec/201012)

Carbon Monoxide Alarm Battery Operated

**Recommended materials:** Battery Operated Carbon Monoxide Alarm
**Tools Required:** pliers, flathead screwdriver, Phillips screwdriver (for enclosed fixtures)
**Standards:** Select CO alarms that are listed and labeled in accordance with UL 2034, or approved by the authority having jurisdiction, and have a minimum of 10-year manufacturer's warranty and contain internal non-replaceable 10-year batteries. Battery operated CO alarms will be installed accordance with manufacturer specifications. Provide occupants the manufacturer’s written user’s manuals. See appendix CO detection alarm selection guide for smoke alarm battery operated selection tips.
**Reference:** SWS number 2.0102.1 [https://sws.nrel.gov/spec/201021](https://sws.nrel.gov/spec/201021)
Section 2: Low-Flow Showerheads and Low-Flow Faucet Aerators

Section 2.1 Low-Flow Showerheads

**Recommended materials:** Fixed low-flow showerhead (hand-held showerheads, if applicable); thread tape, cloth

**Tools required:** Plumbers wrench, scissors

**Standards:** 1.75 gallon per minute (GPM) rate or less for showerhead at 80 pounds per square inch (PSI) according to ANSI/ ASME A112.18.1M.

**Reference:** SWS number 7.0201.1b [https://sws.nrel.gov/spec/702011](https://sws.nrel.gov/spec/702011)

**Installation Guidelines:**

1. Ensure that the shower is a functional shower.
2. Inspect the existing showerhead and determine that it can be safely removed without damaging plumbing apparatus. (i.e., if plumbing pipes are too loose, there may not be enough leverage to remove showerhead without damaging the apparatus).
3. Using plumbing wrench, unscrew the existing showerhead. If the washer has hardened, it should be replaced.
4. Clean out any grit in the exposed pipe.
5. Run water with showerhead off for 10 seconds to remove any remaining grit and sediment inside the exposed plumbing.
6. Install plumbing thread tape on the threads of the plumbing apparatus. (This prevents wearing of the threads over time that may lead to the threads becoming stripped).
7. Install new showerhead and tighten. Be sure to put a cloth over showerhead, so that the wrench does not damage or mark the new showerhead. Tighten until tension no longer turns the aerator any further, then check for leaks. DO NOT over tighten.
8. Make sure that there is no water squirting or leaking from the showerhead connection. If there is leaking or squirting, unscrew and try again with additional thread tape.
Section 2.2 Low-Flow Faucet Aerators

**Recommended materials:** Low-flow faucet aerator; cloth

**Tools required:** Small wrench

**Standards:** 1.5 gallon per minute (GPM) rate or less for aerator at 80 pounds per square inch (PSI) according to ANSI/ASME A112.18.1 and ANSI/INSF61.

**Reference:** SWS number 7.0201.1b [https://sws.nrel.gov/spec/702011](https://sws.nrel.gov/spec/702011)

**Installation Guidelines:**

1. Close the drain so you don't lose any parts down the sink. If there is no way to close the drain, place a small bowl in the sink to catch anything you drop and cover the drain hole.
2. Using your hand or a small wrench, unscrew the aerator in a clockwise direction.
3. Once you remove the aerator you will notice one or more parts contained within. Note the order and orientation of the parts as you remove them.
4. As you take them out you will probably find grit and rust. Rinse the pieces with water and brush off the debris. For difficult to remove deposits, soak the parts in white vinegar for a few minutes and scrub with a toothbrush. If any parts are cracked or broken, replace them. If the washer has hardened, it should be replaced.
5. Clean out any grit in the exposed faucet.
6. Run water with aerator off for 10 seconds to remove any remaining grit and sediment inside the faucet apparatus.
7. Install new aerator and tighten. (If using a wrench, use a cloth between it and the faucet to avoid marring the finish of the new aerator). (DO NOT over tighten).
8. Make sure that there is no water squirting or leaking from the connection. (If there is leaking or squirting, unscrew and try again using a wrench to tighten it).
Section 3: Light Emitted Diode (LED) Bulbs or Compact Fluorescent Light (CFL) Bulbs

**Recommended materials:** LED or CFL bulb

**Tools required:** pliers, flathead screwdriver, Phillips screwdriver (for enclosed fixtures)


**Reference:** SWS number 7.0103.1 [https://sws.nrel.gov/spec/701031](https://sws.nrel.gov/spec/701031)

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**Installation Guidelines:**

1. Ensure that the Priority List criteria is followed:

   Replace incandescent bulbs used more than one hour per day with LED or CFL lamps. Maintain or moderately improve existing lighting levels (lumens) while minimizing wattage. Choose the highest efficacy (lumens per watt) bulbs. Be sure to install bulbs that are sizable replacement bulbs, i.e. dimmable LED/CFL’s in fixtures controlled by dimmer switches; outdoor bulbs in exposed outdoor fixtures; enclosed globes; appropriate orientation (base upright/downwards).

<table>
<thead>
<tr>
<th>Existing Incandescent Wattage to Replace</th>
<th>New LED Lamp Wattage</th>
<th>Maximum Cost per Lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 – 60 W</td>
<td>5 – 9 W</td>
<td>$10</td>
</tr>
<tr>
<td>75 – 100 W</td>
<td>13 – 18 W</td>
<td>$15</td>
</tr>
<tr>
<td>150W +</td>
<td>20 – 25 W</td>
<td>$20</td>
</tr>
</tbody>
</table>

2. Ensure that light fixture is turned off.
   - Examine light fixture for any safety issues such as exposed / frayed wiring or the fixture not being securely attached to the wall or ceiling. (If repairs cannot be made with WAP H&S or other funds, defer the home.”)

3. Remove the light fixture’s lens (if applicable).
4. Unscrew and remove the existing light bulb or for tube light, remove by unlocking the spring from fixture.
5. Visually inspect the socket for safety.
6. Select LED/CFL bulb or LED tube light based on:
   - Wattage or brightness
   - Correlated Color Temperature (CCT); most room and reading light is in the 2,700 – 3,300 K range, outdoor lighting up to 6,000 K.
   - Fixture application:
     - Exterior/Outdoor rated bulb
     - Dimming bulb
     - Timer/photocell control rated bulb
7. Install the LED or CFL bulb by screwing it into the socket or for LED tube light, insert into socket.
8. Reassemble the light fixture lens (if applicable).
9. Turn the light fixture on to ensure the LED or CFL or LED tube light is operable.
10. Client education provided on proper disposal of CFL bulbs, health and safety should a CFL bulb break, and information on how to obtain replacement CFL bulbs.

The covering that prevents direct access to the light bulb(s) is called the lens. It is usually held in place by screws or springs. Remove the lens, replace the bulbs, and replace the lens.
Section 4: Refrigerators

Recommended materials: Energy Star refrigerator

Tools required: level, flathead screwdriver, phillips screwdriver (for door assembly), appliance dolly

Standards: Refrigerators should conform to the following: UL 250, 10th Edition (1/1/1993). Replaced units must be disposed of properly per Clean Air Act 1990, Section 608, as amended by 40 CFR 82 (7/1/2006).


Units with through-the-door icemakers are not allowed. Units should be the same size (cu ft) or smaller than the unit being removed, unless replacing 2 appliances (2 refrigerators, or one refrigerator and one freezer), with one replacement refrigerator.

Installation Guidelines:

1. Ensure that the Priority List criteria is followed:

   Refrigerator testing and replacement
   Replacement refrigerator with energy-efficient model if testing shows annual consumption is high enough to justify measure cost. Estimate annual electricity consumption by metering or locate usage in a database. Prior to metering, ensure that refrigerator/freezer temperatures are adjusted to the proper ranges (freezer temperature between 0 degrees and 5 degrees F and refrigerator temperature between 38 degrees and 42 degrees F. When metering, a minimum 2-hour test shall be done. If the existing refrigerator uses more electricity than the minimum use threshold below, it can be replaced with a new unit.

<table>
<thead>
<tr>
<th>Refrigerator</th>
<th>Minimum kWh / 2 Hour (if metering)</th>
<th>Minimum Annual kWh to Qualify for Replacement (if using database [kWh/yr])</th>
<th>Maximum Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 cu. ft. or less</td>
<td>.18</td>
<td>788</td>
<td>$700</td>
</tr>
<tr>
<td>16 – 19 cu. ft.</td>
<td>.20</td>
<td>876</td>
<td>$900</td>
</tr>
<tr>
<td>20 – 24 cu. ft.</td>
<td>.22</td>
<td>964</td>
<td>$1,100</td>
</tr>
<tr>
<td>25 cu. ft. or larger</td>
<td>.28</td>
<td>1,266</td>
<td>$1,600</td>
</tr>
</tbody>
</table>

   If the client uses more than one refrigerator and all qualify to be replaced, encourage the client to allow for the removal of both refrigerators. The new refrigerators can be larger than the replaced refrigerators so long as it accommodates the household’s needs and can physically fit in the home. Always attempt to reduce the number of refrigeration (refrigerators and freezers) units in the home. The Energy Auditor/Educator must show the customer a picture of the new
refrigerator, measure to ensure the new refrigerator will fit in the client’s home, and have the client sign off on the audit form.

Cost must include purchase, delivery and installation of the new refrigerator, and removal and environmentally responsible de-manufacturing of the old unit. Replacement should be determined by using Energy Star guides and formulas designed for Guam that takes into consideration ambient temperatures.

Best practices for testing refrigerators include:

▪ If you interrupt a compressor cycle, wait 8 minutes before plugging it back in
▪ If door is closed and you still have wattage showing on the meter, perhaps the door switch is broken or the anti-sweat heater is running
▪ The usual running range (compressor on) is 200-400 Watts. Newer refrigerators draw about 150 Watts
▪ Watch for defrost periods (~Watts)
▪ Unplug a refrigerator to clean the coils
▪ Record the temperature inside the fresh food compartment and the freezer compartment  
  a. New units cannot have through-the-door water/ice service  
  b. Required to meter at least 10% of units  
  c. Replaced refrigerators must be recycled and refrigerant reclaimed

2. Unplug the existing refrigerator.
3. Remove the doors of the existing refrigerator.
4. Carefully remove the existing refrigerator from the client’s dwelling. (Note: Watch for any spilling liquids as you begin to move the unit.)
5. Clean the floor area where new refrigerator will be placed.
6. Carefully bring the new refrigerator into the dwelling and ease it into place. Leave 1-2” between the back of the refrigerator and the wall to allow air circulation around the coils. Ensure that the refrigerator fits into the space without blocking light switches, cabinet doors, etc.
7. Assemble the doors of the unit along with interior shelves, trays, bins, etc.
8. Plug the cord directly into a GFCI outlet. Do not use extension cords or power strips. The refrigerator should be plugged into its own dedicated GFCI outlet.
9. Lay a level across the top of the refrigerator to make sure the unit is level. If it isn't level, remove the front grille at the base of the fridge, tilt the refrigerator back and place a wooden block under the front edge. Find the leveling legs on the front corners, and screw them up or down to level the unit.
10. Consult the owner's manual on how to hook up the interior icemaker, if applicable.
11. Instruct the customer to run the refrigerator for at least 4 hours before putting perishable food into it.
12. Set temperature controls appropriately per manufacturer’s recommendations.
13. Give operator manual (owner's manual) and warranty information to the client, and provide client education on proper operation and maintenance of the refrigerator.
14. Proper disposal of the unit is required per Program requirements. Ensure that the disposal contractor is removing and handling refrigerant according to EPA guidelines. Provide a copy of the removal certification in the Contractor’s report for the job file. Disposal documentation should be provided by the recycling center.
Section 5: Air Conditioner

Section 5.1 Room Air Conditioner – Sizing Guidelines
Source – www.energystar.gov

<table>
<thead>
<tr>
<th>Area to be Cooled (square feet)</th>
<th>Capacity Needed (BTUs per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 to 150</td>
<td>5,000</td>
</tr>
<tr>
<td>150 to 250</td>
<td>6,000</td>
</tr>
<tr>
<td>250 to 300</td>
<td>7,000</td>
</tr>
<tr>
<td>300 to 350</td>
<td>8,000</td>
</tr>
<tr>
<td>350 to 400</td>
<td>9,000</td>
</tr>
<tr>
<td>400 to 450</td>
<td>10,000</td>
</tr>
<tr>
<td>450 to 550</td>
<td>12,000</td>
</tr>
<tr>
<td>550 to 700</td>
<td>14,000</td>
</tr>
<tr>
<td>700 to 1,000</td>
<td>18,000</td>
</tr>
<tr>
<td>1,000 to 1,250</td>
<td>21,000</td>
</tr>
</tbody>
</table>

Sizing Adjustments:
- Heavily shaded – Reduce capacity by 10%.
- Very sunny – Increase capacity by 10%.
- Add 600 BTUs for every occupant after 2 that usually occupy the room.
- In kitchen – Add 4,000 BTUs.

If installed in corner, choose unit that can direct airflow in appropriate direction.

Section 5.2 Room Air Conditioner – Window Installation

**Recommended materials:** Air Conditioner

**Tools required:** level, drill, flathead screwdriver, phillips screwdriver, plywood exterior, lumber treated wood, silicone caulk, caulking gun, paint, paint roller/brush, tapcon hex-head screws, self-drilling screws, wood screw, work gloves, hammer-drill if going through concrete.

**Standards:** The supplied window type air conditioning units shall use refrigerant R-410A and be ENERGY STAR qualified model.

**Reference:** SWS-Subtopic 5.0301.1 Room Air Conditioners. [https://sws.nrel.gov/spec/503011](https://sws.nrel.gov/spec/503011)
Installation Guidelines:

1. See Section 5.1 sizing guidelines above to determine the proper size air conditioner.
2. Ensure that the Priority List criteria is followed:
   - Replacement units should be the same size, or smaller, than existing.
   - Minimum usage is at least 8 hours per day.
   - Small (10-15,000 Btu/h cooling capacity) Room Air Conditioner Replacement
     - Existing units with a maximum EER of 9.8 or lower are eligible for replacement
     - New units should have a minimum EER of 12 or be ENERGY STAR-certified
     - Cost is limited to $650
   - Very Small (6-8,000 Btu/h cooling capacity) Room Air Conditioner Replacement
     - Existing units with a maximum EER of 9.7 are eligible for replacement
     - New units should have a minimum EER of 12.2 or be ENERGY STAR-certified
     - Cost is limited to $500
3. Carefully remove the existing air conditioner and the related hardware. Be careful not to tip the unit too much as there may be water inside the unit if it was exposed to rain.
4. Install the mounting brackets that came with the new air conditioner unit.
5. Attach the side extensions to the air conditioner per manufacturer's instructions.
6. Slide the air conditioner into the window opening and attach to the mounting brackets.
7. Lower the window sash down onto the top of the unit.
8. Pull out the side extensions on each side of the air conditioner and attach them securely to the window frame.
9. Using pieces of foam (may be provided by the manufacturer), seal around the top and bottom of the air conditioner unit and the window.
10. Attach the drainage hose (if supplied) to the outside of the air conditioner.
11. Plug in the air conditioner, turn it on, and verify functionality.
12. Set temperature controls appropriately.
13. Remove all packing material from client’s dwelling. Note: Removed units infested with pests are to be enclosed before removal.
14. Give operator manual (owner's manual) and warranty information to the client and provide client education on the normal operation and maintenance of the unit.
15. Proper disposal of the unit is required per Program requirements. Ensure that the disposal contractor is removing and handling refrigerant according to EPA guidelines. Provide a copy of the removal certification in the Contractor’s report for the job file.
Section 5.3 Room Air Conditioner – Through the Wall Installation

Recommended materials: Air conditioner

Tools required: level, drill, flathead screwdriver, phillips screwdriver, plywood exterior, silicone caulk, caulking gun, paint, paint roller/brush, tapcon hex-head screws, wood screws, work gloves, hammer-drill if going through concrete.

Standards: The supplied window type air conditioning units shall use refrigerant R-410A and be ENERGY STAR qualified model.

Reference: SWS-Subtopic 5.0301.1 Room Air Conditioners. https://sws.nrel.gov/spec/503011

Installation Guidelines:

1. See Section 5.1 sizing guidelines above to determine the proper size air conditioner.
2. Ensure that the Priority List criteria is followed:
   - Replacement units should be the same size, or smaller, than existing.
   - Minimum usage is at least 8 hours per day.
   - Small (10-15,000 Btu/h cooling capacity) Room Air Conditioner Replacement
     - Existing units with a maximum EER of 9.8 or lower are eligible for replacement
     - New units should have a minimum EER of 12 or be ENERGY STAR-certified
     - Cost is limited to $650
   - Very Small (6-9,999 Btu/h cooling capacity) Room Air Conditioner Replacement
     - Existing units with a maximum EER of 9.7 are eligible for replacement
     - New units should have a minimum EER of 12.2 or be ENERGY STAR-certified
     - Cost is limited to $500
3. Carefully remove the existing air conditioner from the wall. Be careful not to tip the unit too much as there may be water inside the unit if it was exposed to rain.
4. If there is an existing air conditioner chassis, remove it from the wall.
5. Remove the new air conditioner from its chassis, and mount only the chassis in the wall opening.
6. Use a level to match the manufacturer’s specifications for sloping the chassis slightly downward (towards the outside) for proper drainage.
7. Fasten the chassis to the frame with the proper screws.
8. Install any mounting brackets, if applicable, that may be included with the new air conditioner unit (follow the manufacturer's instructions).
9. Slide the air conditioner into position inside the chassis. (For heavy units, 2 people may be needed).
10. Secure the air conditioner to the chassis as necessary per the instruction manual.
11. Install flashing or drip rail on the exterior to prevent water from dripping inside the wall or down the side of the building.
12. Insulate gaps between framing members, reusing pieces of the old insulation if possible.
13. Frame in plywood carefully around the opening of the wall unit.
14. Finish and sand the plywood to conceal the seams.
15. Paint the wall with as close to matching color as possible.
16. Use silicone caulk around the exterior of the wall unit to seal the seams between the chassis and the siding. (Silicone caulk is flexible enough to maintain a seal next to a vibrating machine).
17. Plug in the air conditioner, turn it on, and verify operational functionality.
18. Set temperature controls appropriately.
19. Remove all packing material from client’s dwelling. (Note: Units infested with pests are to be enclosed before removal).
20. Give operator manual (owner's manual) and warranty information to the client and provide client education on the normal operation and maintenance of the unit.
21. Proper disposal of the unit is required per Program requirements. Ensure that the disposal contractor is removing and handling refrigerant according to EPA guidelines. Provide a copy of the removal certification in the Contractor’s report for the job file.

Section 5.4 Mini-Split Air Conditioner

Recommended materials: Split Air conditioner

Tools required: adjustable wrench, torque wrench, hex keys, or allen wrenches, drill and drill bits, hole saw, utility knife, wire cutter, stripper, phillips screwdriver, flat blade screwdriver, level, safety glasses, work gloves.

Special tools: manifold gauges, vacuum pump, flaring tool, dry nitrogen tank with regulator,

Standards: The supplied mini split type air conditioning units shall use refrigerant R-410A and be ENERGY STAR® certified or equivalent.

Select residential equipment in accordance with the current version of ANSI/ACCA Manual S (Residential Equipment Selection) or equivalent.

Select outdoor units that are corrosion-protected for marine climate zones.

Perform residential load calculation in accordance with the current version of ANSI/ACCA Manual J (Residential Load Calculation) or equivalent using interior design temperatures of 75 degrees for cooling.

Room by room load calculations will be performed when installing multiple indoor units. Calculated loads based on post-retrofit dwelling characteristics.
Install outdoor unit and indoor unit according to manufacturer specifications and applicable building code (e.g., IRC, IMC, IBC) and ANSI/ACCA Standard 5 (HVAC Quality Installation Standard). Install electrical wiring according to NFPA 70, and provide an electrical disconnect within site of the outdoor unit. Install all high voltage wiring inside of protective conduit and approved junction boxes, no wiring connections (high or low voltage) will occur outside of appropriate junction box.

**Reference:** SWS-Subtopic 5.0108.3 Mini-Split System. [https://sws.nrel.gov/spec/501083](https://sws.nrel.gov/spec/501083)

**Installation Guidelines:**

1. See Section 5.1 sizing guidelines above to determine the proper size air conditioner.
2. Ensure that the Priority List criteria is followed:
   - Replacement units should be the same size, or smaller, than existing.
   - Minimum usage is at least 8 hours per day.
   - Existing units with a maximum EER of 10.1 (11.5 SEER) or lower are eligible for replacement
   - New units should have a minimum EER of 13.4 (15.3 SEER) or ENERGY STAR-certified
   - Cost is limited to:
     - i. $1,000 for unit with 9,000 Btu/h cooling capacity
     - ii. $1,250 for unit with 12,000 Btu/h cooling capacity
3. Carefully remove the existing outdoor condenser unit and indoor air handler from the wall.
4. New installation – choose a secured location for the unit to be installed. Location should be secured from inlet and outlet and should be at least 6 feet from the floor.
5. Remove the wall bracket from the back of the mini split indoor air handler.
6. Hold the bracket in place on the wall. Use a level to ensure it is horizontally level then mark the screw holes with a pencil.
7. Drill the marked holes to create a pilot hole and use appropriate sized self-tapping screws with anchors to fix the wall mounting frame. Check the wall mounting frame is firmly in attached by pulling on it.
8. Create a hole in the wall to allow refrigerant lines, control wires and condensation drain to go outside. The hole should be about 2-1/2” to 3 inches. Using a hole saw bit, drill the hole making sure to angle downward to the outside for proper condensate drainage.
9. The wall mounted air handler ships with the refrigerant piping on the right and the drain tube on the left. This can be reconfigured to the particular application (follow the manufacturer's instructions).
10. Bundle the control wire, refrigerant lines and drain tubing together with electrical tape to make sure it'll fit easily through the wall.
11. Lift the unit into place and carefully past the bundled pipes and wires through the wall opening.
12. Place the air handler on the wall mount making sure it is firmly secured and your refrigerant line condensate tube and electrical cables are completely through the wall. Now you can make the multi-conductor wire connections.
13. After cutting the length and stripping the wire, make the connections using a screwdriver. Replace the wiring clip, wiring cover and close the front cover.
14. Install the outdoor heat pump condenser. Choose the outdoor units location based on your home structure, local codes and convenience of installation.
15. Placement of unit can be on a pad, mounted on an exterior wall using brackets or place it on a rooftop.
16. A pad is the simplest and easiest method. The outside unit should be securely mounted with bolts through the footholds before making any connections.
17. With the condenser securely mounted you can make your outside connections. The air handler unit comes pressurized with nitrogen. You'll hear this harmless gas release when you remove the plug.
18. Connect the flared copper ends of the line set to the pipe joint connected to the air handler using the adjustable wrench to hold the piping joint and prevent twisting. Place the torque wrench on the Union nut and tighten to the setting specified the manual.
19. Next connect the drain hose by push-fit and secure with tape. Carefully bend the two bundle to be flush with the wall making sure not to crimp the copper or drain tubing. Line set covers are an optional accessory that hides the appearance of refrigerant lines and control wires.
20. Mount the backing to your exterior wall and once the lines are run snap the covers in place.
21. Next remove the panel that covers the refrigerant valves and wiring connections. Some models may already have the valves exposed. Remove the protective screw caps from the valves.
22. Now you can connect the pipe joint of the outdoor unit to the copper line set.
23. Start the union nut by hand, then use the torque wrench tightening to the specifications in your manual.
24. Next connect the multi-conductor wire that has run from the indoor air handler to the associated terminals on the outdoor unit.
25. Double check the color coding to ensure the wires have been connected correctly.
26. A trained professional is recommended to complete the installation at this point.
27. If the copper pipes are not flare ready or if you wish to cut your line set to a shorter length, you will need to use a flare tool to create a new flair connection.
28. Use a pipe cutter to cut the copper pipe to the desired length and a shaper to deeper the cut. Be sure to put your union nut in place first, then insert the end of the pipe into a flare tool. Improper flaring is the main reason for refrigerant leaks. Refer to your installation manual for more detail in making proper flare connections. Make sure the flare connection is not tilted, cracked or otherwise damaged before connecting.
29. The refrigerant system must be completely sealed in order for the system to perform properly.
30. Start with a pressure test to check for leaks. Using a yellowjacket adapter will allow you to connect standard service equipment to the mini split service ports.
31. Use refrigerant (e.g., R410A) and pressurize the line set and air handler to 115 to 145 PSIG. Then, using a soap bubble solution, spray down all of the flare joints and watch for bubbles to appear. If bubbles are present, tighten the union nut or if necessary, re flare the copper.

32. Next, the technician will use a vacuum pump engages to remove all air and moisture prior to releasing refrigerant into the lines. After the vacuum is complete, close the manifold gauge valve. Use an adjustable wrench to remove the service valve caps and use an Allen wrench or hex key to fully open both service valves releasing refrigerant into the system.

33. The condenser requires 110-volt power from a dedicated circuit on your breaker panel run through an exterior mounted manual disconnect box.

34. A qualified technician should install the circuit breaker, disconnect box and make a high-voltage connection to the condenser.

35. With the refrigerant released, and all high and low voltage connections complete, it's time to power up the system and do the initial startup. Start the system with the remote and check for proper operation.

36. Use silicone caulk to seal the hole from the exterior. (Silicone caulk is flexible enough to maintain a seal next to a vibrating machine).

37. Turn on the air conditioner and verify operational functionality.

38. Set temperature controls appropriately.

39. Give operator manual (owner's manual) and warranty information to the client and provide client education on the normal operation and maintenance of the unit.

40. Remove all packing material from client’s dwelling.

41. Proper disposal of the unit is required per Program requirements. Ensure that the disposal contractor is removing and handling refrigerant according to EPA guidelines. Provide a copy of the removal certification in the Contractor’s report for the job file.
Section 6: Heat Pump Water Heater

**Recommended materials:** Heat Pump Water Heater (HPWH) (see below for sizing guidelines), if condensate drain pump is required, must have minimum capacity of 1 gallon/day.

**Tools required:** Appliance dolly, wrench, pliers, level, hammer, shims, wire strippers, 10 gauge wire, plumbing tools (details will depend upon type of piping used)

**Standards:** UL Listed, UL 1995, Edition 142 (2/18/2005); Electrical components to be listed by UL.

**Reference:** SWS-Subtopic 7.0302.3 Heat Pump Water Heater.  
https://sws.nrel.gov/spec/703023

Specific installation guidelines will vary by model. Installers must refer to Installation Manual provided with model to be installed. The following are notes about key considerations when installing HPWHs.

**Installation Guidelines:**

1. Use the sizing guidelines below:
   - HPWH can replace a similar sized electric water heater.
   - If switching from gas to electric, the HPWH must be the next size larger than the existing gas water heater.
2. Ensure that the Priority List criteria is followed:
   - Household should have a minimum of 3 persons.
   - New units should have an EF of 3.0 or higher
   - Replace only electric resistance water heaters.
   - Cost is limited to $1,850.
3. The water heater must be located in a clean, dry, protected area.
4. Do not install the water heater in outdoor, unprotected areas.
5. If the water heater is installed in a room smaller than 700 cubic feet (10'x10'x7') for GE models, or 1,000 cubic feet for Rheem models, the door to the room must be a louvered door with louvers covering at least 240 square inches of the door.
6. Clearance around the unit must adhere to manufacturer specifications, typically between 2" and 5.5" behind and on sides. The top of the unit must have enough clearance to allow for filter cleaning, 8" to 14" depending on the model.
7. Using the level and shims, make sure the unit sits level.
8. Install provided tubing on the main drain and overflow drain according to manufacturer instructions. Main drain line must be routed to a gravity floor drain or stand pipe which is no higher than 36" from the floor. If no such drain is available, a condensate pump with a minimum capacity of 1 gal/day must be purchased and installed.
9. Do not reduce drain line size less than connection size provided on condensate drain.
10. Insulate the drain line where necessary to prevent sweating and damage due to condensate forming on the outside surface of the line.

11. Determine if a check valve exists in the inlet water line. You may need to check with the local water utility, as this may be installed as part of the water meter. If a check valve has been installed that causes a "closed water system" an expansion tank will need to be installed between the water heater and the check valve.

12. Contact a knowledgeable contractor, water supplier, or plumbing inspector for additional information on the subject of expansion tanks.

13. Install a shut-off valve in the cold water line near the water heater.

14. DO NOT apply heat to the HOT or COLD water connections. If sweat connections are used, sweat tubing to adapter before fitting the adapter to the cold water connections on heater. Any heat applied to the water connections will permanently damage the unit.

15. Install temperature and pressure relief valve in the opening provided and marked for the purpose on the water heater. No valve of any type should be installed between the relief valve and the tank.

16. The pressure rating of the relief valve must not exceed the maximum working pressure of the water heater as marked on the rating plate.

17. The BTUH rating of the relief valve must not be less that the input rating of the water heater as indicated on the rating label on the front of the water heater (1 watt = 3,412 BTUH). Orient the tubing so that any discharge from the valve exits within 6" of the structural floor.

18. Wire according to specific manufacturer instructions. All wiring must conform to local codes or the latest edition of National Electrical Code (NEC) **ANSI/NFPA 70**.

19. Power supply voltage must agree with water heater rating. The voltage requirements and wattage load for the water heater are specified on the rating label on the water heater. 10 gauge wire used for connections.

20. Proper ground connection is essential!

21. If metallic conduit or metallic sheathed cable approved for use as a grounding conductor are used, they must be installed with fittings appropriate for the purpose of grounding.

22. Give operator manual (owner's manual) and warranty information to the client and provide client education on the normal operation and maintenance of the unit.

23. Remove all packing material from client’s dwelling.

24. Proper disposal of the unit is required per Program requirements. Ensure that the disposal contractor is removing and handling refrigerant according to EPA guidelines. Provide a copy of the removal certification in the Contractor’s report for the job file.

25. If nonmetallic sheathed cable, metallic conduit, or metallic sheathed cable not approved for use as a ground conductor are used, you must include a separate conductor for grounding. It should be attached to the ground terminals of the water heater and the electrical distribution box.

26. The tank must be fill of water before the heater is turned on.

27. Make certain the drain valve is completely closed.

28. Open one or more hot water faucets in the home to allow air to escape from the water heater it fills up with water.

29. Open the shut-off valve in the cold water supply line.
30. A steady flow of water from the hot water faucet(s) indicates a full water heater.
31. Turn on the unit according to manufacturer instructions.
32. Provide the client with the user's manual.
33. Discuss with the client all safety and maintenance considerations related to the HPWH.
SMOKE ALARM & CARBON MONOXIDE DETECTORS

How We Test Smoke and Carbon Monoxide Detectors
Each smoke and carbon monoxide detector that enters Consumer Reports’ labs is rigorously tested to make sure these devices keep you and your family safe. For smoke detectors, we test their response time to both flaming fires and smoldering, smokey fires. We’ve found that not all detectors can adequately detect both fire types.

For carbon monoxide detectors, we test them against low CO levels (at 100 parts per million) and high CO levels (at 400 ppm). We also test the accuracy of their carbon monoxide measurements if they offer readings through a digital display or audio announcements. Combination detectors go through both sets of tests, while smart detectors receive additional testing for their wireless connectivity and smartphone alerts. All of these test results are then folded into our comprehensive smoke and carbon monoxide detector ratings.

Types of Smoke and Carbon Monoxide Detectors
You can find standalone smoke detectors and carbon monoxide detectors, as well as combination smoke and carbon monoxide detectors in smart and non-internet-connected forms. All three detector types offer standalone and interconnected varieties. Consumer Reports has yet to test a combination detector that is effective at detecting carbon monoxide, smoldering fires, and flaming fires, which is why we recommend consumers use a combination of detectors in their homes for complete protection.
Smoke Detectors
Fires burn differently: Some flare, some smolder. You’ll find three types of smoke detectors on the market, but only one is effective against both types of fire.

**Ionization Smoke Detectors** are best at detecting the small particles typical of fast, flaming fires. But in our tests, all tested poorly for detecting smoky, smoldering fires. Ionization units are prone to false alarms from burnt food and steam, so don’t mount them near a kitchen or bathroom.

**Photoelectric Smoke Detectors** are best at detecting the large particles typical of smoky, smoldering fires but poor at detecting fast, flaming fires. Photoelectric units are less prone to false alarms from burnt food, so they may be a better fit in kitchen areas.

**Dual-Sensor Smoke Detectors** combine ionization and photoelectric technology to detect both flaming and smoldering fires, offering you the best protection and saving you the hassle of installing two separate smoke detectors. But you may still need to install carbon monoxide detectors, if appropriate for your home.

[Smoke Detectors Ratings]

Carbon Monoxide Detectors
Carbon monoxide detectors use sensors to detect the presence of CO in your home. Some models include digital displays to show the level of CO they detect, and some can read out the CO level via audio messages. Remember,
carbon monoxide detectors do not detect smoke or explosive gases, such as natural gas, propane, and methane.

**Carbon Monoxide Detectors Ratings**

**Combination Smoke and Carbon Monoxide Detectors**
Combination detectors incorporate ionization or photoelectric technologies and carbon monoxide detection to protect against both smoke and CO. Both conventional (not internet-connected) and "smart" models are available.

Smart detectors offer additional features through a companion smartphone app. Features include smartphone alerts about smoke/CO (even when you're not home) and low batteries, as well as the ability to hush alarms from your phone. Some models connect to the internet via WiFi, while others require an additional bridge or hub, which are standalone devices that connect smart home devices to the internet.

Consumer Reports has yet to test a combination detector with both ionization and photoelectric sensors that can capably detect CO, flaming fires, and smoldering fires. We tested one smart model that claims to have all three sensors, but it still failed our flaming fire test, which ionization sensors are designed to detect.

**Our challenge to manufacturers:** Produce a single device that successfully senses both kinds of fire as well as CO.

**Where to Place Them Throughout Your Home**

Smoke detectors are a must in all homes, and carbon monoxide detectors are needed for any home with fuel-burning appliances such as a furnace, water heater, range,
cooktop, or grill. Even those living in all-electric homes should install carbon monoxide detectors, because CO can seep into the house from an attached garage or if a backup generator is used too close to your living quarters during a power outage.

You’ll need smoke detectors that detect flaming and smoldering fires for each bedroom, with at least one detector installed on each floor, including in a finished attic and in the basement. You should also have a carbon monoxide detector on each living level, in the basement, and near (not inside) an attached garage.

Use the illustration below as a guide to where you need detectors and tally up the number of smoke and carbon monoxide detectors you need to buy. Keep in mind that your home might need more or fewer detectors depending on its size and number of rooms.

Illustration: Chris Philpot

Smoke & Carbon Monoxide Detector Ratings

How to Shop for Detectors
1. Check Local Regulations
Before you shop, check regulations in your area. Your town or state might have specific requirements (such as when you sell your home) about what you need, including types of detectors and their placement. Also, some insurance companies offer a discount for homes with smoke detectors.

2. Pick a Power Source
Hard-wired smoke and carbon monoxide detectors tie into your home's wiring, which requires professional installation, and usually have backup batteries. Battery-only detectors are the simplest to install, and they work during a power failure. Some models use removable batteries that require annual replacement, while others use sealed lithium batteries that last the life of the detector. Plug-in detectors are also available, but electric outlets are typically located low on the wall, while the optimal placement for the detector is on or near the ceiling.

3. Smart or Not
Smart smoke and carbon monoxide detectors give you the advantage of knowing if something's wrong when you're not home, but they also come with a big price tag. We also haven't found a smart smoke and CO detector that successfully does it all. But if you do decide to outfit your home with them, we recommend also installing additional dual sensor smoke detectors. Smart detectors, whether hard-wired or battery-powered, will also interconnect with other detectors of the same model.

Another option is the Roost Smart Battery, which replaces the nine-volt battery in smoke and CO detectors that use them. It adds WiFi, smartphone alerts, and in-app hushing (for battery-powered models only) to existing detectors. A third option is a smart listening device like the Leeo Smart Alert or Kidde RemoteLync Smart Home Monitor, which listen for existing detectors’ alarms and send you alerts when they go off.

4. Look for the UL Stamp
Check the detector packaging to make sure it meets the Underwriters Laboratories Standard—look for the UL label. You should also look for the date of manufacture printed on the back of the detectors. Devices lose their sensitivity over time, so the fresher, the better. As a rule of thumb, replace carbon monoxide detectors every five years and smoke detectors every 10 years.

UL has also announced updates to its standards, which will require all manufacturers to make smoke detectors that can distinguish between smoldering fires and cooking smoke by May 2020. And as part of UL’s updated standard, it is expected that manufacturers will not be able to make “traditional, single sensor” (photoelectric or ionization) smoke detectors after May 2020.
5. The Truth About Interconnected Detectors
You can interconnect some smoke and carbon monoxide detectors so that all units in the house sound an alarm when any single one is triggered. Some newer homes may have wiring already in place to link the detectors. In a home without such wiring, you can buy detectors that interconnect wirelessly. These interconnected smoke and carbon monoxide detectors are an important safety feature in a home with multiple levels, although standalone detectors may be adequate for a small, single-level home.

While interconnected alarms can make your home safer, they do have some limitations. In many cases interconnected alarms can only interconnect with models made by the same brand. In fact, the National Fire Protection Association’s Senior Electrical Specialist Richard Roux told CR that you should always check with the manufacturer to see which specific models are compatible, even within the same brand, as some brands could change their interconnect system over time.

Despite the limitations, we still recommend using interconnected detectors. They can make your home much safer by alerting you to danger before the fire or CO spreads throughout your home. Roux adds that interconnected alarms (whether hardwired or wireless) are also becoming a requirement in many states when you try to sell your home.

6. Consider Voice Alerts
Children tend to sleep more deeply than adults and may not awaken to a conventional alarm. Some smoke and combination smoke and carbon monoxide detectors use a voice command, but it’s not confirmed whether that’s the most effective way to wake children. According to one study, a greater percentage of children ages 6 through 12 awoke to the sound of their mother’s prerecorded voice than to a tone alarm.

7. Consider Your Security System
You can incorporate some smoke and carbon monoxide detectors into a system that sounds an alarm outside and inside the house. Such systems may also have a monitoring service that can notify the police or fire department, or even call your cell phone.
Features You'll Find

The latest smoke and carbon monoxide detectors have added features to better protect you and your family. Here's what to consider when tailoring the safest combination of detector options to your household's needs.

Battery Backup
A backup battery for hardwired smoke and carbon monoxide detectors offers security in case of a power failure. All battery-powered smoke and carbon monoxide detectors warn you when the battery is low. Some provide warning chirps, a low battery voice message, or a visual display.

Smartphone Alerts from Smart Detectors
Smart smoke and carbon monoxide detectors connect to smartphone apps that can alert you when detectors go off, even if you’re not home. They will also let you know when batteries are running low so you can avoid pesky chirping.
Digital Carbon Monoxide Display
This feature displays carbon monoxide concentrations in parts per million, even when the concentrations are below the level that triggers the detector. Carbon monoxide detectors certified by UL must go off at no less than 70 ppm, but lower amounts may harm heart patients. The display can alert you if the carbon monoxide level is inching up or is higher than usual. Some also show the peak level since they were reset, warning you of any spikes that occurred while you were away. Expect to pay a little extra for this feature: $5 or $10 for standalone detectors, slightly more for smart detectors.

Hush Button
To silence a nuisance smoke detector, pressing a hush button is more convenient than disabling the unit, and it avoids the possibility of forgetting to turn it back on. All the smoke detectors we tested had this feature. Some carbon monoxide and combination CO/smoke detectors can work with a remote control to silence a nuisance alarm.
Safety and Strobe Lights
Some smoke detectors provide path illumination, a potential life-saver in the dark. There are also alarms with strobe lights, which are the best warning for the hearing impaired. Some smoke detectors have an integrated strobe light, and some accept add-on strobes.

Installation and Maintenance
Smoke and carbon monoxide detectors are only protective when installed correctly and if their batteries are replaced annually. Smoke rises, so mount smoke detectors on the ceiling or high on the wall. Test smoke and carbon monoxide detectors weekly and vacuum them monthly. Follow the manufacturer’s recommendations regarding battery replacement. Replace carbon monoxide detectors every five years and smoke detectors every 10 years.

Brands

FIRST ALERT
First Alert owns the BRK branded units, and the ONELINK line of wireless, talking units. Products include plug-in, battery, hardwired, and hardwired with battery-backup units. First Alert also makes units that detect carbon monoxide and smoke as well as dual sensor units, which combine ionization and photoelectric technologies.

KIDDE
Kidde owns FireX branded units and offers the Nighthawk and Silhouette lines. Nighthawk comes in plug-in and battery operated units. The Silhouette line comes in hardwired units and features a sealed, self-charging lithium battery that lasts for the life of the unit. Kidde offers combo units, which have a smoke detector feature in addition to the carbon monoxide detector. Kidde also makes dual sensor units that use ionization and photoelectric technologies.

OTHER BRANDS
The main manufacturers of smoke detectors and CO alarms are First Alert and Kidde, representing three-quarters of the market. Other manufacturers include: Nest, Swann, Gentex, Firex, Code One, Honeywell, Universal S