BPI-1200-S-202x

STANDARD PRACTICE FOR BASIC ANALYSIS OF BUILDINGS

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This standard has been formulated under the cognizance of the BPI Single-Family Standards Technical Committee (SF-STC).

Introduction

~~(Informative)~~

The Building Performance Institute, Inc. (BPI) publishes standards related to the energy efficiency and performance of residential buildings. Although this standard is primarily focused on energy conservation measures and criteria, it does extend beyond these measures to address the building as a whole. The auditor's role may vary depending on the context in which the evaluation is conducted. The "auditor" may be an independent third party, an employee of a contractor, or a weatherization agency; ~~or~~ it may also be a person conducting an evaluation of the building for other purposes including post-installation performance verification, quality assurance inspections, or other diagnostic interventions. This standard assumes auditors will also follow in good faith their company policy and also conform to the policies of any participating program sponsor or funding source, as applicable, concerning energy-savings estimates and cost-benefit analysis. The recipient of the results of the evaluation can include property owners, program administrators, or other interested parties.

It is understood that other standards or guidelines may be required by the Authority Having Jurisdiction (AHJ) and in such instances, the energy auditor should comply with the AHJ's requirements.

Organizations that elect to include a BPI 1200 annex within the scope of their implementation of this standard shall comply with all applicable requirements of that annex. Organizations may adopt an annex independently or in conjunction with the requirements of the main body of this standard.

- **Informative Annex** – A part of the standard that contains non-mandatory information to provide guidance in understanding or applying the standard. Informative annexes do not contain requirements and are not part of the standard's normative provisions.

- **Normative Annex –** A part of the standard that contains mandatory requirements that must be followed to substantiate conformance/compliance with the standard.

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1 Scope

1.1 This standard practice defines the minimum criteria ~~and specific procedures~~ for conducting a building science-based residential ~~energy audits and related diagnostic tests~~ whole-building assessment, as specified herein.

1.2 ~~The energy audit and related diagnostic tests~~ The assessment shall include an audit that will address energy usage, water usage, and limited aspects of building durability, ~~and~~ occupant comfort, health and safety. ~~The energy audit~~ The audit report will provide a comprehensive ~~report with a~~ list of prioritized recommendations to improve the energy efficiency of the home and to address related health and safety, comfort, and building durability issues, as identified in this standard. The audit report will include a cost-benefit analysis.

1.3 Residential building types covered herein are defined as existing detached single-family dwellings, ~~and~~ townhouses ~~that:~~, and condos, or as defined by the AHJ.

- ~~have independent mechanical systems for each dwelling unit (heating, cooling, water heating, and ventilation)~~
- ~~have direct access to outdoors for each dwelling unit~~
- ~~were designed to have continuous party walls with no penetrations to adjacent units, with such party walls extending from ground to roof where the dwelling unit is attached to one or more adjacent single-family dwelling units.~~

1.4 This standard parallels ANSI/BPI-1100-T-~~201x~~2023,[1] Home Energy Auditing Standard (ANSI/BPI-1100) and provides specific procedures regarding how to meet the requirements detailed in ANSI/BPI-1100.[1]

1.5 BPI-1200 includes a series of annexes, which may be amended from time to time. These annexes are:

- Annex A | Homeowner/Occupant Questionnaire (Informative)
- Annex B | Alternate Procedure for Solid Fuel Burning Appliance Inspection (Informative)
- Annex C | Determining Ventilation Requirements (Informative)
- Annex D | Action Levels for Spillage and Carbon Monoxide in Combustion Appliances (Normative)
- Annex E | Water Efficiency Assessment of Single-Family Dwellings (Normative)

1.6 Definitions and acronyms in BPI-1200 follow the National Laboratories of the Rockies (NLR) Standard Work Specifications Glossary.[2]

2 General Requirements

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 2, General Requirements.

3 Health and Safety Related Requirements

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 3, Health and Safety Related Requirements.

4 Disclosure and Ethics

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 4, Disclosure and Ethics.

5 Cost Benefit Analysis

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 5, Cost-Benefit Analysis. In addition, cost-benefit analysis shall be completed using one of the following methods:

5.1 Computer analysis using qualified energy audit software in accordance with the U.S. Department of Energy's (DOE) ~~Weatherization Program Notice (WPN) 05-5~~ Weatherization Program Notice (WPN) 23-6.[3]

5.2 Computer analysis, using building energy simulation software that shall at a minimum meet the following requirements:

5.2.1 Pass the software verification tests listed in Section ~~4.2.1~~ 3.3 of 2020 Procedures for Certifying Residential Energy Efficiency Tax Credits— ~~RESNET Publication No. 13-001, January 15, 2013.~~ RESNET Publication No. 001-20, July 27, 2020.[4]

5.2.2 Be capable of reporting energy consumption separately, by fuel type, for the following end uses at a minimum: space heating, space cooling, water heating, lighting, and other appliances.

5.3 A priority list set up as described in DOE WPN 23-6 ~~DOE WPN 01-4~~. The priority list shall include both seasonal and baseload home performance upgrades and shall identify the type of housing covered by the priority list. (See *References* at the end of the standard ~~See Annex A BPI-1200-S-201x Referenced Documents~~.)

5.4 Generally accepted engineering estimates.

5.5 Other methods as required by the AHJ.

5.6 When software is used for cost-benefit analysis in accordance with Ssections 5.1 and 5.2, and that software does not fully comply with ANSI/BPI-2400-S-2012 Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History (ANSI/BPI-2400), BPI-2400-S-2015 v.2,[5] the user shall ensure that at a minimum, the values from Table 3.4.i Input Constraints of that standard are followed, as applicable.

5.7 The auditor shall make every effort to obtain records of previous energy usage of all fuels as detailed in utility histories. When such energy- consumption records are available, the audit shall include an analysis of energy consumption records to validate estimates of energy savings from the proposed and/or installed energy conservation measures (ECMs) using one of the following procedures:

5.7.1 ANSI/BPI-2400

5.7.2 Other methods approved by the AHJ

5.8 A cost-benefit analysis shall be included in the audit. The cost-benefit analysis shall include an analysis of available energy consumption records to validate estimates of energy savings from the installed home performance upgrades.

6 Prioritizing Recommendations

The auditor shall comply with the requirements of ANSI/BPI-1100, Section 6, Prioritizing Recommendations.

7 Combustion Appliance and Fuel Distribution System Inspection

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 7, Combustion Appliance and Fuel Distribution System Inspection. In addition, the inspection of combustion appliances and fuel distribution systems shall be conducted as follows:

7.1 Equipment requirements for combustible gas and carbon monoxide (CO) detection, CO measurement, depressurization and spillage tests

7.1.1 Combustible gas detector (CGD)

7.1.1.1 CGD equipment used for testing shall:

7.1.1.1 7.1.1.1.1 Be classified to UL 913[6] Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations, or equivalent.

7.1.1.2 7.1.1.1.2 Have a variable tick rate or changing tone based on gas concentration levels. Note: The tick rate provides the indication of concentration but only accounts for relative concentration changes, not necessarily identifying hazardous concentration thresholds.

7.1.1.3 7.1.1.1.3 Be capable of providing a digital display of percentage of Llower Eexplosive Llimit (LEL) and/or provide an alarm

when detecting combustible gas concentrations exceeding 10% ~~Lower Explosive Limit (~~LEL~~)~~.

~~7.1.1.4~~ 7.1.1.1.4 Be calibrated and/or operation checked in accordance with the manufacturer's recommendations with available documentation traceable to the individual device. While periodic functional "bump tests" are recommended, a full factory or laboratory recalibration is required **annually (minimum every 12 months)** or whenever the device fails a field accuracy check.

~~7.1.1.5~~ 7.1.1.1.5 Have the ability to zero out in ambient conditions.

7.1.1.1.6 Be calibrated to the gas being used in the piping system.

7.1.2 CO measurement equipment

7.1.2.1 Equipment/instruments used for flue gas CO measurement shall:

~~7.1.2.1~~ 7.1.2.1.1 Be capable of measuring, and displaying digitally, ~~carbon monoxide (~~CO~~)~~ levels from 0 to 2,000 parts per million (ppm).

~~7.1.2.2~~ 7.1.2.1.2 Be capable of calculating and displaying digitally, CO air free concentrations, or have digital displays of CO as measured and oxygen (O^2) levels to allow manual calculation of CO air free.

~~7.1.2.3~~ 7.1.2.1.3 Have a resolution of 1 ppm.

~~7.1.2.4~~ 7.1.2.1.4 Have an accuracy of +/- 5% of reading or +/- 10ppm, whichever is greater.

~~7.1.2.5~~ 7.1.2.1.5 Be equipped internally or externally with a nitric oxide filter (NOx filter).

~~7.1.2.6~~ 7.1.2.1.6 Be calibrated in accordance with the manufacturer's recommendations with available documentation traceable to the individual device.

7.1.3 Ambient CO monitor

7.1.3.1 Auditors performing CO inspections shall be equipped with a dedicated ambient CO monitor while in the work environment. "Work environment" includes the building being audited and ambient air and other exposure environments preceding entry of the audited property.

7.1.3.2 CO monitors shall be operated in accordance with the manufacturer's instructions.

7.1.4 Equipment required for depressurization and spillage assessment

7.1.4.1 Mirror, smoke pencils, or other smoke visualization equipment.

7.1.4.2 One or more manometer(s), which shall:

7.1.4.2.1 Have a resolution of 0.1 Pascal (Pa) or better and an accuracy of +/- 1% of pressure reading or +/-0.~~1~~25 Pa, whichever is greater.

7.1.4.2.2 Be calibrated and/or operation checked per current manufacturer's specifications with available documentation traceable to the individual device.

7.2 Immediate health and safety concerns

7.2.1 The auditor shall identify building-related conditions as covered in the scope of this document that may require immediate health and safety remediation in accordance with subsequent sections of this document.

7.2.2 The auditor shall communicate these situations clearly and immediately to the homeowner/occupant and recommend contacting a qualified professional for proper repair and/or maintenance.

7.3 Conditions for entry and working environment associated with indoor air quality

The auditor shall conduct the procedures within Sections 7.3.2 and 7.3.3 to measure ~~carbon monoxide (~~CO~~)~~ and combustible gas levels in the indoor air environment and take action as required. Only after CO and combustible gas levels are found to be below levels calling for evacuation of the home (per Sections 7.3.2.2 and 7.3.3.2.1 ~~7.3.3.3.1~~) shall further work be undertaken.

7.3.1 CGD, ambient CO monitors, and CO measurement

7.3.1.1 Instruments shall be turned on outside the building away from any combustion outlets and automobile traffic areas, set to zero, and otherwise prepared for use in accordance with manufacturer's instructions.

7.3.2 Combustible fuel gases

7.3.2.1 Indoor ambient air shall be sampled with the CGD in at least one location per level of the home. ~~floor of occupied space upon entering the home.~~

7.3.2.2 If any measured concentrations of combustible fuel gas exceed 10% of the LEL, the auditor shall inform the homeowner/occupants of the unsafe condition and advise evacuation of the home. The auditor shall leave the home and the appropriate emergency services and fuel gas providers shall be notified from outside the home.[1]

7.3.3 Carbon monoxide

7.3.3.1 Ambient CO monitoring and measurements

[1] The auditor shall contact the appropriate emergency services only if the homeowner/occupant is unable to do so.

7.3.3.1.1 The auditor shall have a designated ambient CO monitor operating at all times while in the work environment.

7.3.3.1.2 The auditor shall comply with CO exposure action levels specified in Section 7.3.3.~~3~~2 of this document and shall not proceed with work when CO concentrations in the work environment exceed 70 ppm.

~~7.3.3.2 Indoor ambient CO measurements~~

~~7.3.3.2.1~~ 7.3.3.1.3 Upon entering the building, the ambient air shall be sampled to determine the level of CO in the building by conducting measurements in the occupied space, including utility rooms.

~~7.3.3.2.2~~ 7.3.3.1.4 The auditor shall continue to monitor CO levels in the ambient air at all times while in the work environment.

~~7.3.3.3~~ 7.3.3.2 Indoor ambient CO action levels

~~7.3.3.3~~ 7.3.3.2.1 Actions in response to ambient CO measurements shall be taken as follows. These thresholds and actions were adapted from those found in ANSI Z223.1/NFPA 54.[7]

~~7.3.3.3.1~~ 7.3.3.2.1.1 If the CO instrument indicates an ambient CO level of 70 ppm or greater, the auditor shall 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.

~~7.3.3.3.2~~ 7.3.3.2.1.2 If the CO instrument indicates an ambient CO reading in the range of 36 ppm-69 ppm, the auditor shall 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 for further investigation and repair.

~~7.3.3.3.3~~ 7.3.3.2.1.3 If the CO instrument indicates an ambient CO reading in the range of 9 ppm-35 ppm, the auditor shall 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 for further investigation and repair.

7.4 Order of inspection procedures

7.4.1 After the auditor has verified that combustible fuel gases are below 10% of the LEL (per ~~s~~Section 7.3.2.) and that ambient CO readings are below 70 ppm (per ~~s~~Section 7.3.3.2.), the following inspections, as applicable to the specific circumstances of the home being evaluated, shall be performed in the order in which they are listed below.

~~7.4.1~~ 7.4.1.1 Natural Gas and Liquid Petroleum (LP) Gas Piping System Inspection

~~7.4.2~~ 7.4.1.2 Oil Supply System Inspection

~~7.4.3~~ 7.4.1.3 Visual Inspection of Combustion Appliance Zone (CAZ)

~~7.4.4~~ 7.4.1.4 Combustion Appliance Safety Inspection

~~7.4.5~~ 7.4.1.5 ~~Solid Fuel Burning~~ Wood or Pellet Burning Appliance Inspection

~~7.4.6~~ 7.4.1.6 Placing Appliances Back in Operation

7.5 Natural gas and LP gas piping system inspection

7.5.1 An inspection of the fuel piping system(~~/~~s) shall be performed. Where the auditor identifies deficiencies in materials, connections, components, or supports, the deficiencies shall be noted in project documentation along with a recommendation that the homeowner/occupant contact a qualified professional to inspect the system.

~~7.5.1~~ 7.5.2 Systems shall be inspected and tested in accordance with ~~the ANSI Z223.1/NFPA 54, National Fuel Gas Code, Chapter 8, Inspection, Testing, and Purging, and where called for by the authority having jurisdiction (AHJ), shall be tested in accordance with~~ Annex G~~C~~, Section 3 of ANSI Z223.1/NFPA 54, Gas Piping and Connection Inspections.

~~7.5.1~~ 7.5.3 ***Alternatively, the auditor shall conduct the following inspection tasks:***

~~7.5.2~~ 7.5.3.1 Natural gas and LP gas piping system inspection and leakage testing

7.5.3.1.1 An inspection of the accessible gas piping and connections, from the natural gas meter or LP gas tank to a point where the supply line connects to the gas valve of all appliances shall be completed.

~~7.5.2.1~~ 7.5.3.2 Beginning at the natural gas meter or LP gas tank, conduct a test for gas leakage using a CGD. Where a leak is indicated by the CGD, confirm with leak detection solution. Follow manufacturer's instructions for performing gas leak testing.

~~7.5.2.2~~ 7.5.3.3 In the absence of manufacturer instructions, perform gas leak

testing as follows:

~~7.5.2.2.1~~ 7.5.3.3.1 Hold the CGD wand within an inch of the line, starting at the first joint closest to the outlet of the LP gas tank or natural gas meter outlet.

~~7.5.2.2.2~~ 7.5.3.3.2 Move the CGD wand along the entire gas line at a rate of 1~~"~~ inch per second with the tip above the line for natural gas and below for LP gas. Move the CGD wand in a 360-degree circle completely around each joint at a rate of 1~~"~~ inch per second.

~~7.5.2.2.3~~ 7.5.3.3.2 All connections thereafter shall be tested in the same manner.

~~7.5.2.3~~ 7.5.3.3.2.1 The gas leakage inspection shall include the following components:

~~7.5.2.3.1~~ 7.5.3.2.1.1 The entire gas line and all accessible gas piping fittings from the outlet of the natural gas meter or LP gas tank to a point where the supply line connects to the gas valve of all appliances. Do not move appliances.

~~7.5.2.3.1~~ 7.5.3.2.1.1 Appliance gas valve/regulator housing and connections.

~~7.5.2.4~~ 7.5.3.2.2 Where gas leakage is confirmed, the site shall be marked and the homeowner/occupant shall be notified that repairs should be made. The auditor shall recommend that the homeowner/occupant immediately notify the gas company and/or a qualified professional to evaluate and perform all necessary repairs.[2]

~~7.5.2.5~~ 7.5.3.2.3 When the CGD indicates that combustible gas exists in the ambient atmosphere (at any level below 10% of LEL) and a gas leak cannot be confirmed with the use of leak detection solution, the auditor shall inform the homeowner/occupants and advise the homeowner/occupant to notify the gas company and/or a qualified professional.

~~7.5.2.6~~ 7.5.3.2.4 Inspect fuel lines for visibly worn flexible gas lines and any flexible connectors manufactured prior to 1973. Inspect flexible appliance connectors to determine if they are free of cracks, kinks, corrosion and signs of damage.

[2] The auditor shall contact the appropriate emergency services only if the homeowner/occupant is unable to do so.

~~7.5.2.7~~ 7.5.3.2.5 Where fuel lines or connectors are determined to be unsafe or where an uncoated brass connector is found, notify the homeowner/occupant and recommend that the appliance shutoff valve be placed in the off position and that the connector be replaced.

~~7.5.2.8~~ 7.5.3.2.6 Inspect piping to determine that it is adequately supported, that there is no undue stress on the piping, and if there are any improperly capped pipe openings.

~~7.5.2.9~~ 7.5.3.2.7 Where the auditor identifies deficiencies in gas piping materials, connections, components, or supports, the deficiencies shall be noted in project documentation along with a recommendation that the homeowner/occupant contact a qualified professional to inspect the system.

7.6 Oil supply system inspection

7.6.1 The auditor shall conduct an inspection of the oil-fired appliance fuel supply system (tank, supply lines, burner) for leakage and other deficiencies as detailed ~~in~~ below.

~~7.6.1~~ 7.6.1.1 Inspect oil lines for visible signs of oil leakage, kinks, or other deficiencies that may impair the flow of oil or result in leakage, and verify the oil line is properly connected to the burner.

~~7.6.2~~ 7.6.1.2 Inspect the oil tank, if safely accessible, for evidence of historic or active oil spills or leakage.

~~7.6.3~~ 7.6.1.3 Verify that the tank is at least 5 feet from burner or other sources of fire or flame or installed as per local code.

~~7.6.4~~ 7.6.1.4 Verify that the fill cap is in place and in good condition.

~~7.6.5~~ 7.6.1.5 Verify that the vent pipe is in good condition and free of obstruction and the vent cap is installed and in good condition.

~~7.6.6~~ 7.6.1.6 Verify the presence of a working shutoff at the tank.

~~7.6.7~~ 7.6.1.7 Verify that all lines properly connect to the tank.

~~7.6.8~~ 7.6.1.8 Verify that exposed portions of the fuel line are protected from damage.

~~7.6.9~~ 7.6.2 ~~Fuel Oil Supply System - Action Levels~~ Oil supply system leaks

~~7.6.9.1~~ 7.6.2.1 In the case of a leak, the auditor shall:

~~7.6.9.1.1~~ 7.6.2.1.1 Mark the leak location and notify the homeowner/occupant.

~~7.6.9.1.2~~ 7.6.2.1.2 Advise the homeowner/occupant to contact a qualified professional to repair the leak.

~~7.6.9.1.3~~ 7.6.2.1.3 Follow specific rules and regulations pertaining to the local jurisdiction. Follow specific rules and regulations pertaining to the local jurisdiction.

~~7.6.9.2~~ 7.6.2.2 The auditor shall document compliance or deficiencies on:

~~7.6.9.2.1~~ 7.6.2.2.1 Project documentation, o~~O~~r

~~7.6.9.2.2~~ 7.6.2.1.2 National Oilheat Research Alliance's Routine Fuel ~~Oil~~ Storage Tank Evaluation—Above Ground Tanks ~~C~~checklist,[8] and include with project documentation.

7.7 Visual inspection of combustion appliance zone ~~(CAZ)~~

7.7.1 Inspect the CAZ to determine if there is sufficient clearance between combustion appliances and potential combustibles ~~area is free of the storage of~~ such as gasoline~~, or any flammable products such as~~ oil-based products, solvents, varnishes, ~~or~~ adhesives, aerosol sprays, ~~. Inspect the immediate area where the appliance is located to determine if the area is free of~~ rags, paper, etc. ~~or other combustibles~~ to minimize the risk of fire or explosion.

7.7.1.1 Combustibles are defined as any solid, liquid, or gas that can catch fire and burn when exposed to heat or a spark. Some examples of combustible materials in a home beyond the items noted above may include building materials (drywall, wood framing, etc.), home furnishings (clothing, furniture, etc.), and electronics (wire, plastics, etc.).

7.7.1.2 All combustible materials need a minimum amount of energy before they will ignite. Autoignition temperature is the lowest temperature at which a combustible material will catch fire and sustain burning on its own, without needing a continuous external heat source such as a spark or flame. The auditor should consider materials with autoignition temperatures below 500F as high risk, and special attention should be paid to ensure these materials have sufficient clearance to high temperature sources such as flues, exhausts, etc.

7.7.1.3 Non-combustible materials are defined as substances that will not ignite, burn, support combustion, or release flammable vapors when exposed to fire or extreme heat. Examples include metals, masonry, glass, and some insulating materials such as rockwool.

7.7.2 Determine whether the appliance and its vent connectors have the appropriate clearance from combustible building components in accordance with manufacturer's specifications or locally accepted codes. ~~or Annex E, Table E.1, Clearances to Combustible Material for Unlisted Furnaces and Boilers and Table E.2, Clearances to Combustible Material for Vent Connectors Attached to Appliances with Draft Hoods.~~

Minimum Clearances to Combustible Materials for Vent Connectors Attached to Appliances with Draft Hoods (in inches)[3]	
Vent Material	**Minimum Clearance**
Type B Gas Vent	1
Type L Vent	3
Single Wall Metal Pipe	6

7.7.3 When it is determined that an unsafe condition exists, as specified in Sections 7.7.1 – 7.7.2 above, and the unsafe condition may be mitigated ~~alleviated~~ by removal of obstructions and materials, the homeowner/occupant shall be so advised. If the unsafe condition cannot be immediately mitigated, the auditor shall advise the homeowner/occupant that the appliance should not be used until the unsafe condition is mitigated. Note the condition in project documentation.

7.7.4 If a gas or oil-fired storage water heater is located in a garage, the water heater must be a minimum of 18~~"~~ inches above the floor unless listed as flammable vapor ignition resistant (FVIR). Advise homeowner/occupant of unsafe condition(s) and note in project documentation.

7.8 Visual inspection of combustion appliance(~~/~~s) and venting system(/s)

7.8.1 The evaluation shall include a visual inspection of the heating system(~~/~~s), water heater(~~/~~s), and venting system(~~/~~s).

~~7.8.1~~ 7.8.2 Oil-fired, natural gas or LP gas appliances

~~7.8.1.1~~ 7.8.2.1 Inspect venting system to ensure the materials and horizontal pitch meet manufacturer's specification. In the absence of manufacturer's specifications, verify that the horizontal pitch has a minimum ¼~~"~~ inch rise per linear foot.

~~7.8.1.2~~ 7.8.2.2 When possible, inspect masonry chimneys to determine if they are lined in accordance with the AHJ. If the presence of a liner cannot be determined, recommend that the homeowner/occupant contact a qualified professional to complete a chimney inspection.

[3] Unless otherwise noted by manufacturers' requirements.

~~7.8.1.3~~ 7.8.2.3 Inspect venting for blockage or restriction, leakage, corrosion, unusually small or large vent connectors or other deficiencies that could cause an unsafe condition.

~~7.8.1.4~~ 7.8.2.4 Inspect vent termination and verify the presence of a vent cap (if applicable and safely accessible).

~~7.8.1.5~~ 7.8.2.5 Inspect visible portions of the furnace combustion chamber for cracks, ruptures, holes, and corrosion.

~~7.8.1.6~~ 7.8.2.6 Verify the blower compartment door, filter rack door and/or covers are properly installed.

~~7.8.1.7~~ 7.8.2.7 ~~Wiring:~~ Inspect for bare wires, open wire connections or worn insulation.

~~7.8.1.8~~ 7.8.2.8 If deficiencies are identified per Sections ~~7.8.1.1-7.8.1.7~~ 7.8.2.1 - 7.8.2.7, recommend further inspection by a qualified professional.

~~7.8.2~~ 7.8.3 Direct vent appliances

~~7.8.2.1~~ 7.8.3.1 Verify the combustion air supply pipes are securely fastened to the appliance.

~~7.8.2.2~~ 7.8.3.2 Verify the combustion air source is located in the outdoors or in areas that freely communicate to the outdoors and in a code compliant location.

~~7.8.2.3~~ 7.8.3.3 Inspect plastic venting system(s) to determine that it is free of sagging, free of leaks, and is sloped in an upward direction to the outdoor vent termination.

~~7.8.2.4~~ 7.8.3.4 Inspect vent termination and vent cap, if applicable and safely accessible.

~~7.8.2.5~~ 7.8.3.5 If deficiencies are identified per Sections ~~7.8.2.1-7.8.2.4~~ 7.8.3.1 – 7.8.3.4, recommend further inspection by a qualified professional.

~~7.8.3~~ 7.8.4 Chimney and/or venting system shared by multiple combustion appliances

~~7.8.3.1~~ 7.8.4.1 Combustion appliances vented into a common vertical chimney/flue:

~~7.8.3.1.1~~ 7.8.4.1.1 When a higher BTUh combustion appliance enters the chimney/flue above a lower BTUh combustion appliance, the auditor shall recommend that the homeowner/occupant contact a qualified professional to inspect the venting system.

~~7.8.3.1.2~~ 7.8.4.1.2 When two combustion appliance vents enter at the same horizontal point, the auditor shall recommend that the homeowner/occupant contact a qualified professional to inspect the venting system.

~~7.8.3.2~~ 7.8.4.2 Combustion appliances vented into a common horizontal vent connector:

~~7.8.3.2.1~~ 7.8.4.2.1 If the vent piping diameter does not increase after the additional combustion appliance connection into the vent piping, the auditor shall recommend that the homeowner/occupant contact a qualified professional to inspect the venting system.

~~7.8.4~~ 7.8.5 Unvented heaters

~~7.8.4.1~~ 7.8.5.1 Check appliance for the presence of an *ANSI/CSA Z21.11.2 –Gas Fired Room Heaters-Volume II*[9] label.

~~7.8.4.2~~ 7.8.5.2 Recommend removal of any unvented heater that is not ~~listed to~~ CSA/ANSI Z21.11.2-listed.

~~7.8.4.3~~ 7.8.5.3 Verify that the unvented heater input is a maximum of 40,000 BTUh, but not more than 10,000 BTUh where installed in a bedroom, and not more than 6,000 BTUh when installed in a bathroom.

~~7.8.4.4~~ 7.8.5.4 Recommend removal of any unvented heater that exceeds the maximum allowable BTUh as specified in Section ~~7.8.4.3~~ 7.8.5.3.

~~7.8.4.5~~ 7.8.5.5 Inform clients of potential dangers of unvented space heaters (CO, moisture, oxygen depletion, NO_2), and how these effects could become exacerbated with changes to the building envelope.

7.7 Combustion appliance safety inspection

~~7.9.1~~ After gas or oil piping inspection and a visual inspection of the combustion appliance(~~/~~s) have been completed, and no unsafe conditions related to these inspections have been observed, a combustion appliance safety inspection shall be completed to determine if fossil fuel-fired appliances are operating safely under a depressurized condition.

The auditor shall use the following procedures to conduct a spillage assessment and CO measurements ~~and spillage assessment~~ on natural draft appliances equipped with a barometric draft control, or on ~~or~~ Category I appliances equipped with a draft hood or connected to a natural draft venting system. The evaluation shall also include CO measurement on gas ovens, and on direct-vent and vent-free combustion equipment.

Ambient CO shall be monitored at all times during these tests, and actions taken as per Section 7.3.3.~~3~~2 of this document.

~~7.9.1 Set-up for conduction combustion appliance safety inspection~~

~~The following steps shall be completed for the purpose of placing the CAZ under the greatest depressurization achievable given the weather/temperature conditions at the time of the inspection. Once it has been determined that the greatest possible depressurization has been achieved, the CAZ shall remain in this depressurized state during all spillage assessment and CO measurements conducted in the CAZ.~~

~~7.9.1.1 Place all combustion appliances located within the CAZ in their standby mode and prepare for operation.~~

~~7.9.1.2 Fires in woodstoves and/or fireplaces shall be fully extinguished, with no hot coals or embers, prior to performing a depressurization test. Close fireplace dampers and any fireplace doors.~~

~~7.9.1.3 Close all building exterior doors and windows. Close all CAZ doors. Close the interior doors of all rooms except for rooms with an exhaust fan and rooms with a central forced air system return. Outdoor openings for combustion air shall remain open.~~

~~7.9.1.4 Turn off any mechanical ventilation and forced air cooling or heating system blowers.~~

~~7.9.1.5 Using a calibrated manometer or similar pressure measuring device intended for this purpose, measure and record the baseline pressure in the CAZ with reference to (WRT) outside. Compare this measurement with subsequent pressure measurements to determine the greatest negative pressure achievable in the CAZ.~~

~~7.9.1.6 Turn on the following exhaust equipment: clothes dryers (check and clean the dryer filter and look for blockage at the external vent damper prior to operation), range hoods, and other exhaust fans. If there are speed controls, operate the exhaust equipment at the highest speed setting. Do not operate a whole house cooling exhaust fan.~~

~~7.9.1.7 Measure and record the pressure in the CAZ WRT outside.~~

~~7.9.1.8 Turn on any central forced air system blowers and measure and record the pressure in the CAZ WRT outside.~~

~~7.9.1.8.1 If the pressure in the CAZ becomes more negative WRT outside after the blower is turned on, the blower shall remain on during combustion appliance safety inspection.~~

~~7.9.1.8.2 If the pressure in the CAZ becomes more positive WRT outside after the blower is turned on, the central forced air system blowers shall be turned off during the combustion appliance safety inspection.~~

~~7.9.1.9 Open interior door/s directly leading to the CAZ. Measure and record the pressure in the CAZ WRT outside.~~

7.9.1.9.1 If the pressure in the CAZ becomes more negative WRT outside after the door(s) are opened, the door(s) shall remain open during the combustion appliance safety inspection.[4]

7.9.1.10 Starting with the appliance with smallest BTUh input rating, follow lighting instructions and place in operation. Adjust the thermostat or control so the appliance will operate continuously.

7.9.2 Spillage assessment and CO measurement in cold vent (except domestic water heaters)

7.9.2.1 Spillage shall be assessed at 5 minutes of main burner operation.

7.9.2.1.1 Action levels for spillage occurring at 5 minutes of main burner operation shall be in accordance with Annex D, Table D.1.A.

7.9.2.2 CO measurement of undiluted flue gas shall be taken at 5 minutes of main burner operation. The CO measurement shall be compared with the appropriate CO threshold in Section 7.9.5, Table 1, CO Thresholds for Fossil Fuel-Fired Appliances (Table 1).

7.9.2.2.1 Action levels for CO exceeding the appropriate threshold in Section 7.9.5, Table 1 shall be in accordance with Annex D, Table D.1.B.

7.9.2.2 CO measurement of undiluted flue gas shall be taken at 5 minutes of main burner operation. The CO measurement shall be compared with the appropriate CO threshold in Section 7.9.5, Table 1, CO Thresholds for Fossil Fuel-Fired Appliances (Table 1).

7.9.3 Spillage assessment and CO measurement in domestic water heaters or warm vent

7.9.3.1 Spillage shall be assessed at 2 minutes of main burner operation.

7.9.3.1.1 Action levels for spillage occurring at 2 minutes of main burner operation shall be in accordance with Annex D, Table D.1.A.

7.9.3.2 CO measurement of undiluted flue gas shall be taken at 5 minutes of main burner operation. The CO measurement shall be compared with the appropriate CO threshold in Section 7.9.5, Table 1.

7.9.3.2.1 Action levels for CO exceeding the appropriate threshold in Section 7.9.5, Table 1 shall be in accordance with Annex D, Table D.1.B.

[4] Alternatively, pressure differential diagnostics may be used to determine proper door configuration to create the greatest CAZ depressurization. Pressure differential diagnostics may include manometer readings or a visual indicator, such as smoke.

7.9.1 CAZ setup methods

There are two CAZ setup methods that can be utilized to conduct safe and effective combustion appliance safety inspections. Which method is utilized will depend on local or program needs and requirements.

7.9.1.1 The **Simple CAZ setup** method is a way to quickly determine if a home's combustion appliances are at risk of exhaust spillage or have high levels of CO. The procedure uses a standard method for setting interiors doors open or closed. The **Simple** CAZ setup and depressurization method is described in detail in Sections 7.9.2 and 7.9.3.

7.9.1.2 The **Analysis CAZ setup** method[5] provides a more detailed evaluation of a home's combustion appliance safety as part of a whole home analysis. It examines the risk of exhaust spillage and CO production under a wider range of depressurization conditions than the Simple CAZ setup. Interior door positions are determined by individual pressure Measurements or visual indicators, rather than a standard door setup, building upon the Simple CAZ setup. The **Analysis** CAZ setup and depressurization method is described in detail in Sections 7.9.4 and 7.9.5.

7.9.2 Simple CAZ setup

The following steps shall be completed for the purpose of placing the CAZ under the greatest depressurization achievable under the Simple CAZ setup guidelines, given the weather and temperature conditions at the time of the inspection. Once that scenario has been determined, the CAZ shall remain in that specific depressurized scenario during all subsequent spillage assessments and CO measurements conducted in the CAZ.

7.9.2.1 Place all combustion appliances located within the CAZ in their standby mode and prepare for operation.

7.9.2.2 Fires in wood stoves and/or fireplaces shall be fully extinguished, with no hot coals or embers, prior to performing a depressurization test. Close fireplace dampers and any fireplace doors.

7.9.2.3 Close all building exterior doors and windows. Close all CAZ doors. Close interior doors of all rooms except those with an exhaust fan or a forced air system central return. Outdoor openings for combustion air shall remain open.

7.9.2.4 Turn off any mechanical ventilation and forced air cooling or heating system blowers.

7.9.3 Simple CAZ depressurization procedures

[5] Analysis CAZ setup procedures described in Sections 7.9.4 and 7.9.5 are used as the technical basis for candidate assessment for BPI's Energy Auditor (EA) certification.

7.9.3.1 Using a calibrated manometer or similar pressure measuring device intended for this purpose, measure and record the initial pressure in the CAZ with reference to (WRT) outside. If necessary, use an appropriate time average of the pressure reading to eliminate wind fluctuations during testing,and use that same time average for all subsequent pressure measurements. .

7.9.3.2 Turn on the following exhaust equipment: clothes dryers (check and clean the dryer filter and look for blockage at the external vent damper prior to operation), range hoods, and other exhaust fans. If there are speed controls, operate the equipment at the highest speed setting. Do **not** operate a whole-house cooling exhaust fan.

7.9.3.3 Measure and record the pressure in the CAZ WRT outside.

7.9.3.4 Turn on all central forced air system blowers (do not allow system(s) to fire, only the blower(s).

7.9.3.5 Measure and record the pressure in the CAZ WRT outside.

7.9.3.5.1 If the air handler has no pressure effect, or a positive pressure effect on the depressurization of the CAZ WRT outside, the system(s) will remain OFF for subsequent testing.

7.9.3.5.2 If the air handler has a negative effect on the depressurization of the CAZ WRT outside, the system(s) will remain ON for subsequent testing.

7.9.3.6 Open interior doors directly leading to the CAZ. Measure and record the pressure in the CAZ WRT outside.

7.9.3.6.1 If the CAZ open scenario has no pressure effect, or a positive pressure effect on the depressurization of the CAZ WRT outside, the door(s) will remain in a CLOSED position for all subsequent testing.

7.9.3.6.2 If the CAZ open scenario has a negative pressure effect on the depressurization of the CAZ WRT to outside, the CAZ door(s) will remain OPEN for all subsequent testing.

7.9.3.7 With all prior scenarios set, including exhaust fans, dryer(s), air handler(s), and CAZ door(s), measure the pressure differential in the CAZ WRT outside. This is the **Simple Worst Case Depressurization**. This scenario must be maintained (or recreated) before conducting exhaust spillage assessments and CO measurements of combustion equipment.

7.9.4 Analysis CAZ setup

The following steps shall be completed for the purpose of placing the CAZ under the greatest depressurization achievable under the Analysis CAZ setup guidelines given weather and temperature conditions at the time of the inspection. Once that scenario has been determined, the CAZ shall remain in that specific depressurized scenario during all subsequent spillage assessments and CO measurements conducted in the CAZ.

7.9.4.1 Place all combustion appliances located within the CAZ in their standby mode and prepare for operation.

7.9.4.2 Fires in woodstoves and/or fireplaces shall be fully extinguished, with no hot coals or embers, prior to performing a depressurization test. Close fireplace dampers and any fireplace doors.

7.9.4.3 Close all building exterior doors and windows. Open all interior doors including CAZ door(s). Outdoor openings for combustion air shall remain open.

7.9.4.4 Turn off any mechanical ventilation and forced air cooling or heating system blowers.

7.9.5 Analysis CAZ depressurization procedures

7.9.5.1 Using a calibrated manometer or similar pressure measuring device intended for this purpose, measure and record the initial pressure in the CAZ with reference to (WRT) outside. If necessary, use an appropriate time average of the pressure reading to eliminate wind fluctuations during testing, and use that same time average for all subsequent pressure measurements.

7.9.5.2 Create an exhaust fans pressure scenario by turning on all local or spot ventilation exhaust fans that are measurable with an exhaust fan flow meter If there are speed controls, operate the equipment at the highest speed setting. Do **not** operate a whole house cooling exhaust fan.

7.9.5.3 Measure and record the exhaust fans scenario pressure in the CAZ WRT outside.

7.9.5.4 Create a dryer exhaust pressure scenario by turning on the clothes dryer(s) (check and clean the dryer filter and look for blockage at the external vent damper prior to operation).

7.9.5.5 Measure and record the dryer exhaust scenario pressure in the CAZ WRT outside.

7.9.5.6 Create a range hood pressure scenario by turning on the cook top or kitchen exhaust fan on its highest speed setting.

7.9.5.7 Measure and record the range hood exhaust scenario pressure in the CAZ WRT outside.

7.9.5.8 Create a central air handler pressure scenario by turning on central forced air system blowers (do not allow the system(s) to fire, only the blower[s]).If the home has more than one forced air system, turn on and measure the pressure change for each system individually, starting with the duct system that has the least exposure to outside to that with the most (e.g., ducts in unconditioned space).

7.9.5.9 Measure and record the central air handler scenario pressure(s) in the CAZ WRT outside, recording multiple if applicable.

7.9.5.9.1 If an air handler has no pressure effect, or a positive pressure effect on the depressurization of the CAZ WRT outside, the system(s) will remain OFF for subsequent testing.

7.9.5.9.2 If an air handler has a negative effect on the depressurization of the CAZ WRT outside, the system(s) will remain ON for subsequent testing.

7.9.5.10 Analysis CAZ setup interior doors configuration

7.9.5.10.1 Starting at the room door furthest from the CAZ, using a manometer and tubing or a visual indicator (such as smoke), close the door and evaluate the room's pressure while standing on the CAZ side of the door.

7.9.5.10.1.1 If the door open has no pressure effect, or a positive pressure effect, on the room WRT the rest of the living space, the door will remain in a CLOSED position for all subsequent testing.

7.9.5.10.1.2 If the door open has a negative pressure effect on the room WRT to the rest of the living space, the door will remain OPEN for all subsequent testing.

7.9.5.10.2 Repeat this process at all interior doors in the home, working back to the CAZ. Set door positions accordingly based upon pressure measurement differential or visual evaluation, WRT the living space.

7.9.5.10.3 Evaluate the CAZ door with manometer or smoke, and set CAZ door position accordingly.

7.9.5.10.3.1 If the CAZ open scenario has no pressure effect, or a positive pressure effect, on the depressurization of the CAZ WRT outside, the door will

remain in a CLOSED position for all subsequent testing.

7.9.5.10.3.2 If the CAZ open scenario has a negative pressure effect on the depressurization of the CAZ WRT to outside, the CAZ door will remain OPEN for all subsequent testing.

7.9.5.10.4 Record setup of all doors throughout the home once pressure or visual evaluations have been completed and door positions are accordingly set.

7.9.5.10.5 With all prior scenarios set, including exhaust fans, dryer(s), range hood(s), air handler(s), interior door(s) position(s), and CAZ door(s) position(s), measure the pressure differential in the CAZ WRT outside. This is the **Analysis Worst Case Depressurization** scenario. Maintain (or recreate) this scenario before moving on to subsequent exhaust spillage assessments and CO measurements of combustion equipment.7.9.5.10.6.

7.9.5.10.6 Each preceding individual scenario (fans, dryers, range hoods, doors, etc.) should be evaluated both individually and collectively to troubleshoot problems with CAZ over-depressurization that could cause spillage of combustion appliances.

7.9.6 Spillage assessment and CO measurement of combustion appliances

Return to or maintain the home in the **Worst Case Depressurization** configuration determined by either the **Simple** or **Analysis** method (outlined in Section 7.9.2) before continuing with spillage assessment or CO measurement procedures.

7.9.6.1 Naturally drafting appliances spillage assessment

7.9.6.1.1 Start with the appliance with the smallest BTUh input rating, follow lighting instructions and place in operation. Adjust the thermostat or control so the appliance will operate continuously.

7.9.6.1.2 Note time on watch, or start timer.

7.9.6.1.3 Exhaust spillage must stop and draft must establish **before** 5 minutes of main burner operation (NFPA 54, Annex G.6 (2).

7.9.6.1.4 Evaluate for presence of spillage using one of the following approved methods:

7.9.6.1.4.1 Using a **smoke generating device**, place smoke slightly below and outside of the draft hood edge and test around the draft hood's entire perimeter.Observe the **smoke**

condition for up to 5 minutes to determine whether draft has been established or whether spillage is occurring; or

7.9.6.1.4.2 Using a **mirror**, place the mirror facing the opening under the draft hood, about 1-3 inches away, moving it methodically around the full perimeter of the draft hood. Observe the **mirror** condition for up to 5 minutes to determine whether draft has been established or whether spillage is occurring.

7.9.6.1.5 Action levels for spillage occurring after 5 minutes of continuous main burner operation shall be in accordance with Annex D, Table D.1.A.

Smoke Spillage Test

Condition	Description	Pass/Fail
1	If smoke flows into the hood at all or most points around the perimeter of the draft hood, this indicates that draft has been established. (Occasionally a small area of neutral air area may be encountered where the smoke does not flow in or out of the draft hood.)	Pass
2	If smoke is neutral and does not flow into or out of the hood, this is a sign of weak draft.	Fail – Refer to Table D.1.A.
3	If smoke is observed flowing away from the draft hood, this is a sign of spillage. (Sudden wind events may cause this to occur, but they should be very short instances, and draft should return immediately after the event.)	Fail – Refer to Table D.1.A.

Mirror Spillage Test

Condition	Description	Pass/Fail
1	If the mirror remains free of exhaust condensation at all, or at most points around the perimeter of the draft hood, this indicates draft has been established. (Occasionally a small area of neutral air area may be encountered where light condensation may form.)	Pass
2	If the mirror has light condensation that forms and quickly clears at more than one location	Fail – Refer to Table D.1.A.

	around the draft hood, this is a sign of weak draft.	
3	If the mirror has obvious and persistent exhaust condensation, this is a sign of spillage. The mirror should be removed, wiped clean, and placed at another point around the draft hood, and repeated as necessary, until the full draft hood perimeter is checked for spillage. (For safety, do not leave the mirror in the stream of spilling exhaust gases.)	Fail – Refer to Table D.1.A.

7.9.6.2 Naturally drafting appliances CO measurements

7.9.6.2.1 CO air-free measurement of undiluted flue gas shall be taken at 5 minutes of continuous main burner operation. The CO air-free measurement shall be compared with the appropriate CO threshold in Section 7.9.7.3, CO Thresholds for Fossil Fuel-Fired Combustion Appliances.

7.9.6.2.2 Action levels for CO exceeding the appropriate threshold in Section 7.9.7 Table 1 shall be in accordance with Annex D, Table D.1.B.

~~7.9.4~~ 7.9.6.3 Multiple combustion appliances sharing chimney and/or venting system

When a chimney and/or venting system is shared by multiple combustion appliances, the auditor shall use the following procedures to test combustion appliances for spillage and measure CO level in undiluted flue gases.

~~7.9.4.1~~ 7.9.6.3.1 Combustion appliances shall be tested in order from lowest BTUh input rating to highest BTUh input rating.

~~7.9.4.2~~ 7.9.6.3.2 The appliance with the lowest BTUh input rating shall be tested ~~assessed~~ for spillage and CO air-free measurement in undiluted flue gas shall be conducted in accordance with Section 7.9.6 ~~7.9.2 (Cold Vent) or 7.9.3 (Warm Vent) of~~ this document.

~~7.9.4.3~~ 7.9.6.3.3 Upon completion of spillage testing and CO measurement of the first appliance, the auditor shall place the next largest BTUh combustion appliance in operation while the first appliance is still firing. Do not wait for the chimney to cool.

~~7.9.4.4~~ 7.9.6.3.4 Retest the first appliance for spillage when the second appliance has reached 2 minutes of main burner operation. Test the second appliance for spillage immediately thereafter.

~~7.9.4.5~~ 7.9.6.3.5 Measure air-free CO level in the undiluted flue gas of the second appliance at 5 minutes of its main burner operation. Continue this process for each additional commonly- vented combustion appliance in order of BTUh input rating until all are running simultaneously.

~~7.9.4.6~~ 7.9.6.3.6 CO measurements shall be compared with the appropriate CO thresholds in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~.

~~7.9.4.7 Action levels~~

~~7.9.4.7.1 Action levels for spillage on each appliance shall be in accordance with Annex D, Table D.1.A.~~

~~7.9.4.7.2 Action levels for CO for each appliance shall be taken in accordance with Annex D, Table D.1.B.~~

~~7.9.5 Table 1: CO Thresholds for Fossil Fuel-Fired Combustion Appliances~~

~~Table 1~~
~~CO Thresholds for Fossil-Fuel Fired Combustion Appliances~~

~~Appliance~~	~~Threshold Limit~~
~~Central Furnace (all categories)~~	~~400 ppm air free[6]~~
~~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 wood burning fireplace)~~	~~400 ppm air free in firebox~~

~~7.9.6~~ 7.9.6.4 Direct-vented and power-vented appliances

~~7.9.6.1~~ 7.9.6.4.1 If the outlet of the exhaust is safely accessible, measure the CO level in the undiluted flue gas on all direct-vented and power-vented appliances (without atmospheric chimneys or vents) at 5 minutes of main burner operation.

~~7.9.6.1~~ 7.9.6.4.2 The CO measurement(s) shall be compared with the appropriate CO threshold/s in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~.

~~7.9.6.1~~ 7.9.6.4.3 Action levels for CO exceeding the appropriate threshold(~~/~~s) in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~ shall be taken in accordance with Annex D, Table D.1.B.

~~[6] See Carbon Monoxide Air Free in Annex B |Terms and Definitions for further details.~~

~~7.9.7~~ 7.9.6.5 Gas ovens and range tops

Gas ovens shall be tested for vented CO and range top burners shall be visually inspected. Perform appliance testing procedures following the manufacturer's appliance procedure. In the absence of the manufacturer's appliance procedure, the following testing procedures and action levels shall be used.

~~7.9.7.1~~ 7.9.6.5.1 With appliance off, complete the following visual inspection:

~~7.9.7.1.1~~ 7.9.6.5.1.1 Check the oven cavity for any stored materials and remove before testing.

~~7.9.7.1.2~~ 7.9.6.5.1.2 Inspect the oven cavity for cleanliness. If the oven area is dirty enough to adversely impact the combustion process recommend that the oven be cleaned to reduce the possibility of unacceptable emissions.

~~7.9.7.1.3~~ 7.9.6.5.1.3 Check the bottom surface inside of the oven cabinet for air venting that may be present. Any air vent obstruction, such as aluminum foil or silicone liners, must be removed before oven CO testing.

~~7.9.7.1.4~~ 7.9.6.5.1.4 Check for air blockage at the bottom of the range and drawer and/or broiler compartment under the oven and remove any obstructions before testing.

~~7.9.7.1.5~~ 7.9.6.5.1.5 Inspect range top burners for cleanliness. If the burners are excessively dirty, or the flame quality is poor (flickering, etc.) recommend that they be cleaned to reduce the possibility of unacceptable emissions.

~~7.9.7.2~~ 7.9.6.5.2 Turn the oven on to its highest ~~a~~ bake temperature, not to exceed ~~of~~ 500°F. Do **not** turn the oven all the way up to the broil setting or self-cleaning setting.

~~7.9.7.2.1~~ 7.9.6.5.3 After 5 minutes of the oven's main burner operation, the auditor shall place the test probe of a CO analyzing tool into the throat of the oven exhaust vent and ~~measure~~ take the undiluted CO as measured test result.

~~7.9.7.2.2~~ 7.9.6.5.4 Record the CO measurement once the ~~CO level~~ reading has stabilized ~~become a stable reading~~.

~~7.9.7.2.3~~ 7.9.6.5.5 The CO measurement shall be compared with the appropriate CO threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~.

~~7.9.7.3~~ 7.9.6.5.6 Actions levels for CO exceeding the appropriate threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~ shall be in accordance with Annex D, Table D.1.B.

~~7.9.8~~ 7.9.6.6 Unvented combustion heating or hearth appliance CO inspection procedures

~~7.9.8.1~~ 7.9.6.6.1 Unvented heaters

~~7.9.8.1.1~~ 7.9.6.6.1.1 With the appliance on its highest setting, ~~measure~~ take the CO air-free measurement after 5 minutes of main burner operation. Compare the CO measurement with the appropriate threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~.

~~7.9.8.1.2~~ 7.9.6.6.1.2 Actions levels for CO exceeding the appropriate threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~ shall be in accordance with Annex D, Table D.1.B.

~~7.9.8.2~~ 7.9.6.6.2 Gas log sets

~~7.9.8.2.1~~ 7.9.6.6.2.1 With the appliance off, if gas logs are installed in formerly wood-burning fireplaces equipped with a damper, verify that the fireplace damper is in a fixed open position.

~~7.9.8.2.2~~ 7.9.6.6.2.2 With the appliance on its highest setting, ~~measure~~ take the CO as measured levels in the firebox (where log sets are installed in wood burning fireplaces) or in the vent (for gas fireplaces) after 5 minutes of main burner operation. Compare the CO measurement to the appropriate threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~.

~~7.9.8.2.3~~ 7.9.6.6.2.3 Actions levels for CO exceeding the appropriate threshold in Section ~~7.9.5~~ 7.9.7.3~~, Table 1~~ shall be in accordance with Annex D, Table D.1.B.

7.9.7 Spillage and CO action levels

7.9.7.1 Action levels for spillage on each appliance shall be in accordance with Annex D, Table D.1.A.

7.9.7.2 Action levels for CO for each appliance shall be taken in accordance with Annex D, Table D.1.B.

7.9.7.3 CO Thresholds for Fossil-Fuel Fired Combustion Appliances

Appliance	**Threshold Limit**
Central Furnace (natural gas or LP)	400 ppm air free
Boiler (natural gas or LP)	400 ppm air free
Floor Furnace (natural gas or LP)	400 ppm air free
Gravity Furnace (natural gas or LP)	400 ppm air free
Wall Furnace	200 ppm air free
Wall Furnace (Direct Vent)	400 ppm air free

Appliance	Threshold Limit
Vented Room Heater (natural gas or LP)	200 ppm air free
Unvented Room Heater (natural gas or LP)	200 ppm air free
Water Heater (natural gas or LP)	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 wood burning fireplace)	400 ppm air free in firebox
Oil-fired or biodiesel appliances (furnaces, water heaters, and boilers)	100 ppm air free[10]

7.10 Wood or pellet ~~Solid fuel~~ burning appliance inspection

7.10.1 This section applies to indoor wood or pellet burning appliances such as stoves, furnaces, and boilers.

~~7.10.1~~ 7.10.2 The auditor shall perform the following visual inspection and/or recommend that the homeowner/occupant contact a certified hearth professional to conduct a thorough inspection of the installation and operation of the appliance.

~~7.10.1.1~~ 7.10.2.1 Identify and record the appliance nameplate information (e.g., model, serial number, EPA rating, safety listing, etc), if available. ~~Identify the listing nameplate on the appliance and record the model name and model number, if available.~~

~~7.10.1.2~~ 7.10.2.2 If possible, ~~D~~determine through homeowner/occupant interview approximately how many hours per week during the heating season the appliance is used, and if the appliance is the primary heating source.

~~7.10.1.3~~ 7.10.2.3 If possible, during the homeowner interview, ~~If the appliance is the primary heating source~~, determine when the chimney and vent connector were last swept ~~cleaned~~ and inspected. Recommend servicing by a certified hearth or chimney professional at least once per year (or at manufacturer-recommended intervals). ~~If they have not been cleaned and inspected within the past year, recommend servicing by a certified hearth professional.~~

~~7.10.1.4~~ 7.10.2.4 Visually inspect the CAZ and note the type and condition of flooring material where the appliance is installed.

7.10.2.5 Check for appropriate clearance to combustible materials from the appliance.

~~7.10.1.5~~ 7.10.2.6 Visually inspect the appliance venting system from the appliance to the vent termination for: vent type/material (if possible), clearances to combustibles, pitch, presence of a rain cap, obvious blockage or restriction, leakage, corrosion, or other deficiencies that could cause an unsafe condition. If deficiencies are noted, recommend further inspection and, if needed, servicing by a certified hearth or chimney professional. ~~A recommendation for service by a qualified professional or a recommendation for replacement of the appliance shall be made if any of the following indicators are noted:~~

7.10.3 A recommendation for service, reinstallation, or replacement of the appliance by a qualified professional shall be made if any of the following indicators are noted:

~~7.10.1.5.1~~ 7.10.3.1 Appliances installed on carpets, wood floors or other combustibles.

~~7.10.1.5.2~~ 7.10.3.2 Inadequate clearance to combustible materials. Where applicable, ~~C~~consult the nameplate on the back of the appliance ~~documentation~~ for required clearances. If the nameplate is not accessible ~~no documentation is available~~, refer to NFPA 211.[11]

~~7.10.1.5.3~~ 7.10.3.3 Obvious ~~S~~signs of structural failure, such as cracks, holes, deformation, or broken welds, of any components, including the venting.

7.7.1.6 ~~When air sealing or insulation measures are recommended in a home with a fireplace insert, recommend the installation of a fireplace insert liner (attached to the insert, not the existing fireplace liner) if an existing insert liner is not in place.~~

7.10.3.4 Evidence of blockage, restriction, leakage, corrosion, flame roll-out, and other deficiencies that could cause an unsafe condition.

7.10.3.5 Defects inside the stove such as missing, damaged, or defective components (door gaskets, dampers, firebricks, etc.).

7.10.3.6 To the extent determinable, excessive buildup of ash deposits, soot or creosote in or on the appliance or flue gas venting system (e.g., soot on mantel or walls).

7.10.3.7 Signs that the appliance is not vented properly, such as: multiple 90 degree angles, absence of a thimble, or double wall chimney pipe where the vent passes through the wall or ceiling.

7.10.3.8 A woodburning fireplace insert does not have a liner that connects the appliance flue collar to the first flue tile in the fireplace chimney.

7.10.3.9 If the home has a woodburning fireplace, check to see if it has a functioning damper and a rain cap. If not, recommend that a damper and rain cap be installed.

7.10.4 Alternatively, and especially for homes where the appliance is the primary heating source, the auditor shall follow the procedure below to inspect wood burning or pellet burning appliances and inserts:

~~7.10.2~~ 7.10.4.1 A visual inspection in accordance with Annex ~~J~~ B, Alternate Procedure for Solid Fuel Burning Appliance Inspection.

7.11 Placing appliances back in operation

7.11.1 If no safety concerns or hazards were identified during the inspection of the combustion appliances, return all inspected appliances and systems to their pre-existing state. If appliance-related safety concerns or hazards were identified during the inspection, follow the appropriate action~~s~~ levels specified in the preceding ~~S~~sections.

Note: In some cases, this will require that the auditor recommend that the appliance be turned off, and the homeowner/occupant be advised to contact a qualified professional for further evaluation.

8 Indoor Air Quality and Ventilation

The auditor shall comply with the requirements detailed in ANSI/BPI-1100, Section 8, Indoor Air Quality and Ventilation. In addition, the evaluation of existing ventilation systems and determination of ventilation requirements shall be conducted as follows:

8.1 Evaluation of existing ventilation systems in the dwelling:

8.1.1 Conduct a visual inspection of existing ventilation systems in the dwelling.

8.1.2 If available, refer to the nameplate or ventilation system documentation provided by the equipment manufacturer, system designer, or installer that could identify the type of system(s), location, designed and tested performance, and/or specifications of the equipment.

8.2 Determine the dwelling unit ~~whole-building~~ ventilation requirements in accordance with ANSI/ASHRAE 62.2-~~2013~~ 2025.[12] ~~Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings (ASHRAE 62.2).~~ (See Annex ~~I~~C, Determining Ventilation Requirements.)

8.3 Project documentation shall specify improvements as required to reduce pollution sources and to provide adequate ventilation consistent with the design strategies described in ANSI/ASHRAE 62.2. Improvement opportunities identified through the audit process shall be identified in project documentation as follows:

8.3.1 Recommend the removal of indoor air pollutants sources identified in ANSI/BPI-1100, Section 8.1, or implementation of other source control measures.

8.3.2 Sealing, gasketing, or weatherstripping all leaks between an attached or tuck-under garage and the house shall be recommended, including specific leakage paths as identified in ANSI/BPI-1100, Section 8.2.

8.3.3 In situations identified in ANSI/BPI-1100, Section 8.3 where any exhaust fan or clothes dryer[7] vents terminate within the building enclosure, including any unconditioned attics or crawlspaces, recommend solutions for terminating the exhaust system(s) directly outdoors. ~~This recommendation shall include existing exhaust fans that are not included as local exhaust, such as toilet room fans.~~

8.3.4 Sealing of air handler units and ducts that are located outside the pressure boundary shall be recommended.

8.3.5 For ducts located outside the pressure boundary, ~~recommend~~ R-8 insulation, at a minimum, shall be recommended.

9 Moisture Control

The auditor shall include a visual/sensory inspection of each home for moisture issues in accordance ~~comply~~ with the requirements detailed in ANSI/BPI-1100, Section 9, Moisture Control.

9.1 In addition, the inspection shall be conducted as follows:

9.1.1 Inspection for evidence of exterior water intrusion such as roof leaks, foundation leaks, fenestration assembly leaks, and ground-water intrusion.

9.1.2 Inspection for evidence of damage caused by interior water sources such as plumbing leaks or condensation on piping, ductwork, or interior surfaces.

9.1.3 Inspection for effects of water damage on buildings such as structural damage, mold, mildew, efflorescence, and stains.

9.1.4 Identification of existing vapor retarders, flashing, gutters, or other moisture-control strategies.

9.2.1 Evaluation of dehumidification appliance(s) operation, condition and efficiency.

9.1.1.1 Identify make and model.

9.1.1.2 Determine estimated hours of use.

9.2.1.3 Determine if it is providing moisture control.

9.2.1.4 Identify type and whether it is connected to a whole house ducted system or standalone appliance.

9.2.1.5 Note location and area of effect.

[7] Exception: condensing exhaust dryers.

10 Building Enclosure

The auditor shall comply with the requirements detailed in ANSI/BPI-1100,[1] Section 10, Building Enclosure. In addition, the evaluation of the building enclosure shall be conducted as follows:

10.1 Evaluation of the building enclosure for insulation levels and performance.

10.1.1 General assessment approach

10.1.1.1 When assessing components of the building for cost-benefit analysis and prioritization, home energy upgrades that are recommended for action shall include adequate detail to ensure accurate savings estimates, including, as applicable: surface area, construction type, existing listed R-value (if available), quantity and condition of the existing insulation, and proposed modifications. Condition considerations include degradation (compression, gaps, water intrusion) or installation issues (misalignment, bare spots).

10.1.1.2 When assessing components of the building enclosure for cost-benefit analysis and prioritization, detailed measurements of components and insulation levels in non-accessible areas are optional. ~~However, specific home energy upgrades that are recommended for action shall include adequate detail to ensure accurate savings estimates, including quantity, surface area, construction type, existing listed R-value (if available), effective R-value, and proposed modifications.~~

10.1.1.1 Throughout the evaluation, note the presence of hazards or potential hazards such as the presence of knob and tube wiring.

10.1.2 Foundation

10.1.2.1 Note the foundation type(s) (e.g., slab on grade, crawlspace, basement), construction type (e.g., stone, brick, poured concrete), location of the thermal boundary, and exposure above grade. ~~When~~ Where feasible, note location, ~~and~~ condition, and/or absence of the pressure boundary (exposed earth) and/or the moisture control layer(s) (e.g., ground moisture barrier, capillary break, drainage plane, vapor control layer, as applicable). ~~barrier.~~

10.1.2.2 If a foundation is a basement or crawlspace, note any intentional venting, and note whether the space is fully conditioned, semi-conditioned (unintentionally conditioned) or intentionally unconditioned.

10.1.2.3 Note any insulation on foundation walls, ceiling (if a basement or crawlspace), and/or floor, as well as any insulation degradation or installation issues. ~~with existing insulation.~~

10.1.2.4 Note all unintended air flow paths, including open wall cavities above the foundation and openings to the outside or ground.
~~Note any thermal bypasses observable from the basement or crawlspace(s), such as chases or open wall cavities that extend up into the structure, as well as air leaks from the foundation space to the ground or outside.~~

10.1.2.5 Recommend measures to control bulk moisture and vapor intrusion, as appropriate.

~~10.1.2.5~~ 10.1.2.6 When home energy upgrades for foundation insulation are proposed, indicate the surface area(s)~~,~~ foundation ~~construction~~ type and material, as well as recommended ~~effective~~ insulation type, R-value, ~~and the~~ thickness~~, type~~ and performance characteristics (e.g., perm rating)~~. of insulation.~~ Insulation recommendations shall be based on the building's moisture control layer(s) (e.g., ground moisture barrier, capillary break, drainage plane, vapor control layer), pressure boundary, and thermal boundary ~~barrier, thermal barrier, air barrier, and drainage plane~~ (as applicable).

10.1.3 Walls

10.1.3.1 Note the wall construction type(s) (e.g., brick, plaster and lathe, etc.) that comprise the thermal boundary, and indicate insulation presence, thickness, ~~and~~ type, and performance (e.g., perm rating). If ~~i~~insulation and construction details within a structure vary ~~depending on~~ in construction type, age of construction, interior or exterior renovations or retrofits, ~~it may be necessary to~~ inspect ~~multiple~~ areas of wall using appropriate method(s) ~~a combination of methods~~ (e.g., visual inspection, non-conductive probe, boroscope, and/or non-destructive imaging) to determine insulation recommendations. When feasible, note location and condition of the pressure boundary and the moisture control layer(s) (e.g., ~~ground moisture barrier, capillary break,~~ drainage plane, vapor control layer, as applicable) ~~barrier~~.

10.1.3.2 Note any significant sources of air leakage between conditioned space and exterior or buffer spaces related to the wall construction. Note likely transition areas for leakage remediation that may not be visible (e.g., garage or porch ceiling framing intersecting with exterior wall).

10.1.3.3 When home energy upgrades for wall insulation are proposed, indicate the ~~surface~~ net area(s) and construction type of the walls to be addressed. Additionally,note the recommended thickness, type, and perm rating of the insulation to be installed.~~and construction type, thickness, type and performance characteristics (e.g., perm rating) of insulation.~~ Insulation recommendations shall consider the building's moisture control layer(s) (e.g, drainage plane, vapor control layer), pressure boundary, and thermal boundary (as applicable). ~~Insulation recommendations shall be based on the building's moisture barrier, thermal barrier, air barrier, and drainage plane (as applicable).~~

10.1.3.4 Inspection of exterior wall components

~~10.1.3.4.1 Note gaps, cracks, holes or other damage in exterior siding and trim.~~ Note deficiencies in exterior cladding or trim (e.g., gaps, cracks, holes, missing, deteriorated, poorly installed, etc.)

~~10.1.3.4.1 Note missing or damaged siding and trim.~~

10.1.3.5 Inspection of exterior electrical components.

10.1.3.5.1 Note if electrical service drop line appears ~~is~~ damaged or meter is poorly ~~not properly~~ anchored to building.

10.1.3.5.2 Note if any ~~if~~ outdoor electric receptacle(s) are not GFCI-protected or lack appropriate weather protection ~~tight~~ cover.

10.1.4 Floors

10.1.4.1 Note the floor construction type(s) that comprise the thermal boundary (e.g., cantilever, garage ceiling, exposed floor on piers, etc.), and indicate insulation presence and type. If ~~I~~insulation and construction details within a structure vary in ~~depending on~~ construction type, age of construction, interior or exterior renovations or retrofits,~~; it may be necessary to~~ inspect ~~multiple~~ areas of floor using appropriate method(s) ~~a combination of methods~~ (e.g., visual inspection, non-conductive probe, boroscope, and/or non-destructive imaging) to determine insulation recommendations. When feasible, note location and condition of the pressure boundary and the vapor control layer(s). ~~moisture barrier.~~

10.1.4.2 Note any significant sources of air leakage between conditioned space and exterior or buffer spaces related to the floor construction.

10.1.4.3 ~~When home energy upgrades for floor insulation are proposed, indicate the surface area(s) and construction type, thickness, type, and performance characteristics (e.g., perm rating) of insulation. Insulation recommendations shall be based on the building's moisture barrier, thermal barrier, air barrier, and drainage plane (as applicable).~~ When home energy upgrades for floor insulation are proposed, indicate the net area(s) and construction type of the floor to be addressed, and the recommended thickness, type, and perm rating of the insulation to be installed. Insulation recommendations shall consider the building's vapor control layer(s).

10.1.5 Attics

10.1.5.1 Note the attic or roof structure framing type(s) (e.g., rafter/joist, truss, vaulted ceiling, etc.), and location of the thermal boundary. When feasible, note location and condition of the pressure boundary and the vapor control layer(s).

10.1.5.2 Note any intentional attic or roof venting, and note whether each space is unconditioned, semi-conditioned (unintentionally conditioned), or fully conditioned.

10.1.5.3 Note the presence, type, listed R-value (if available) ~~and effective R-value,~~ and condition of any insulation on attic ceiling (rafters) and/or floor joists, as well as any degradation (compression, gaps, water intrusion) or installation issues (misalignment, bare spots) with existing insulation.

10.1.5.4 Note the presence, type, and listed R-value (if available) ~~and effective R-value,~~ of any insulation on kneewalls (between conditioned and unconditioned spaces) or gable walls that are part of the thermal boundary.

10.1.5.4 Where there is limited ~~no attic~~ access ~~it may be necessary~~ ~~to~~ inspect ~~multiple~~ areas of attic or vaulted ceiling using appropriate method(s) ~~a combination of methods~~ (e.g., visual inspection, non-conductive probe, boroscope, and/or non-destructive imaging) to determine the presence of insulation and recommendations for upgrade, as needed.

10.1.5.5 Note any thermal bypasses observable from the attic, such as chases or open wall cavities that extend down into conditioned space, and note likely transition areas for leakage remediation that may not be visible (kneewall-to-floor transitions, changes in ceiling height, chimney/duct chases, dropped soffits/stairway ceilings, etc).

10.1.5.6 ~~When home energy upgrades for attic insulation are proposed, indicate the surface area(s) and construction type, thickness, type, and performance characteristics (e.g., perm rating) of insulation. Insulation recommendations shall be based on the building's moisture barrier, thermal barrier, air barrier, and drainage plane (as applicable).~~ When home energy upgrades for attic insulation are proposed, indicate the net area(s) and construction type of the floor/wall to be addressed; and the recommended thickness, type and perm rating of the insulation to be installed. Insulation recommendations shall consider the building's control layer. Also note features such as chimneys, combustion venting, recessed light fixtures, and/or exhaust fans that need repair or exterior venting. Note any floored/enclosed areas to be insulated~~,~~ and specify treatment separately from non-floored areas.

10.1.5.7 Verify the presence of attic ventilation and evaluate adequacy in accordance with the current version of International Residential Code for One and Two-family Dwellings (IRC), Section 806[13] where attic ventilation is required by local code.

10.1.5.9 When attic ventilation is recommended, it shall be consistent with the current version of IRC, Section 806.[12]~~, including the verification of an effective barrier and thermal boundary between the attic and the living space or recommendation for appropriate attic sealing and proper insulation as part of the scope of work.~~

10.2 Building air leakage shall be measured at a 50 Pa of pressure difference relative (WRT) to outdoors, including a baseline pressure adjustment. When 50 Pa cannot be reached, building air leakage at 50 Pa shall be estimated according to the blower door equipment manufacturer's instructions or one of the approved standards below.

10.2.1 Alternatively, one of the following methods may be used to measure or estimate building air leakage at 50 Pa:

- ASTM E779-19[14]
- ANSI/RESNET/ICC 380-2019[15]
- CAN/CGSB-149.10-2024[16]

10.2.2 The house shall be prepared for blower door testing using one of the above methods. Prior to testing, combustion appliances must be turned off or set to pilot. Potentially hazardous materials and contamination sources that could be disturbed by the blower door test must be identified by the auditor and properly mitigated or removed. A blower door test shall not be performed if doing so poses a known health risk to building occupants.

~~10.2 Evaluate the air-leakage of the building enclosure, as determined by a blower door test.~~

~~10.2.1 Conduct the blower door test in accordance with one of the following methods:~~

~~10.2.1.1 ANSI/ASTM E-779-10, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization~~

~~10.2.1.2 CAN-CGSB 149-0010-1986, Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method~~

~~10.2.1.3 Section 802 of the RESNET Mortgage Industry National Home Energy Rating Systems Standards, 1/1/2013~~

~~10.2.2~~ 10.3.2 When home energy upgrades for sealing air leaks are proposed, include the following information:

~~10.2.2.1~~ 10.3.2.1 A list of major leakage areas to be addressed, and an estimate of total leakage reduction that may be achieved in the home based on sealing those leaks.

~~10.2.2.1~~ 10.3.2.2 ~~-~~A recommendation that air sealing be completed/installed prior to insulating surfaces, whenever insulating would compromise or hinder access to the air sealing process.

~~10.2.2.3~~ 10.3.2.3 When air sealing is recommended, include a recommendation that ~~post-installation~~ air leakage testing is required ~~be conducted~~ to verify air sealing results and identify any potential need for mechanical ventilation.

~~10.3~~ 10.4 Evaluate Fenestration

~~10.3.1~~ 10.4.1 Identify ~~predominant~~ window and skylight characteristics:

~~10.3.1.1~~ 10.4.1.1 Frame material (wood, metal, vinyl, fiberglass; presence of thermal break)

~~10.3.1.2~~ 10.4.1.2 Glass type (number of panes, low-e coatings, gas fill)

~~10.3.1.3~~ 10.4.1.3 Significant shading, interior or exterior

~~10.3.1.4~~ 10.4.1.4 Condition and operation

10.4.1.5 Orientation

~~10.3.1.5~~ 10.3.1.6 Where deficiencies are noted, recommend appropriate repairs, retrofit, or replacement with windows that meet or exceed ENERGY STAR® specifications and local building code. When home energy upgrades for one or more window(s) are proposed, indicate both the surface areas and characteristics of each existing window, including orientation.

~~10.3.2~~ 10.4.2 Evaluate exterior door characteristics

~~10.3.2.1 Determine whether the door is insulated.~~

~~10.3.2.2~~ 10.4.2.2 Determine whether the door is wood, metal, or fiberglass.

10.4.2.3 Determine orientation of the door.

10.4.2.4 Determine whether the door is insulated, and/or presence of a storm door.

10.4.2.5 Note when fire rating information is available.

~~10.3.2.3~~ 10.4.2.6 Inspect for missing or damaged caulking around door frame, missing or damaged trim or door components, and visible air leaks. Note if door does not open, close, or lock properly.

~~10.3.2.4~~ 10.4.2.7 Where deficiencies are noted, recommend repair or replacement with doors that meet or exceed ENERGY STAR® specifications and local building code. When home energy upgrades for one or more door(s) are proposed, indicate both the surface areas and characteristics of each existing door.

~~10.4~~ 10.5 Evaluate solar heat gain

~~10.4.1~~ 10.5.1 Evaluate the potential for energy savings of shading or solar-gain-reducing window treatments such as low-e storm windows ~~storms~~, solar films or screens, shading devices, etc.

~~10.4.2~~ 10.5.2 Evaluate the potential for energy savings of shading and solar-reflectance upgrades for the attic, roof and/or wall.

~~10.5~~ 10.6 Project documentation shall include:

~~10.5.1~~ 10.6.1 Enclosure leakage

~~10.5.1.1~~ 10.6.1.1 The measured air-leakage rate of the building enclosure, as determined by a blower door test. When building enclosure air sealing is specified, a post-work blower-door test shall be specified.

~~10.5.1.2~~ 10.6.1.2 A recommendation for enclosure air-sealing when cost-effective. A statement that sealing work be conducted prior to or at the same time as any proposed insulation work.

~~10.5.1.3~~ 10.6.1.3 A statement that an objective of sealing work is to align the pressure boundary with the thermal boundary.

~~10.5.2~~ 10.6.2 Enclosure thermal performance

~~10.5.2.1~~ 10.6.2.1 An estimate of the insulation R-values in the enclosure surfaces that comprise the thermal boundary in accordance with ~~s~~Sections 10.1.2-10.1.5 of this standard.

~~10.5.2.2~~ 10.6.2.2 An estimate of the U-factors and solar heat gain coefficients (SHGCs) of windows and skylights in accordance with ~~s~~Section 10.3 of this standard.

~~10.5.2.3~~ 10.6.2.3 Recommendation of insulation retrofits when cost-effective.

~~10.5.3~~ 10.6.3 Enclosure cooling loads

~~10.6.2.1~~ 10.6.3.1 A recommendation for interior and/or exterior window treatments, such as low-e storm windows, solar films or screens, shading devices, etc., when cost-effective.

~~10.6.2.2~~ 10.6.3.2 A recommendation for shading and solar-reflectance retrofits for the roof and/or walls, when cost-effective.

~~10.5.4~~ 10.6.4 Recommendation for repair of identified moisture damage and/or leaks prior to commencing insulation/sealing work.

11 Heating, Cooling, and Domestic Water Heating Systems

The auditor shall comply with the requirements detailed in BPI-1100,[1] Section 11, Heating, Cooling and Domestic Water Heating Systems. In addition, the evaluation of these systems shall be conducted as follows:

11.1 General requirements

11.1.1 For all appliances included in Section 11 with the exception of domestic water heaters, determine when the appliance was last serviced. If the appliance has not been serviced within the past two years, recommend servicing by a qualified professional as specified in ~~ANSI/ACCA 4-2013: Maintenance of Residential HVAC Systems (ANSI/ACCA 4 QM)~~ ANSI/ACCA 4QM,[17] or the manufacturer's instructions, or by procedures accepted by the AHJ.

11.1.2 Recommendations for further evaluation, repair, or installation related to an HVAC appliance/system or component shall include a recommendation that any such work be conducted by a qualified professional.

11.1.3 When operation of an appliance is required per Section 11, the appliance shall be placed in operation only after it has been determined that it is safe to operate the appliance, per Section 7 of this standard.

11.1.4 For each heating appliance and domestic water heater listed in Section 11, locate and record the system information from the nameplate when available and as applicable to the individual appliance: appliance brand, model, model number, ~~size~~ capacity in BTUh, operating specifications such as the efficiency rating, if available, BTUh input and BTUh output, listed temperature rise, and listed maximum external static pressure.

11.1.5 For each cooling appliance listed in Section 11, note the system information from the nameplate when available, and as applicable to the individual appliance: appliance brand, model, model number, capacity ~~or size~~ in BTUh, refrigerant type, and efficiency. Record listed maximum external static pressure if available on the air handler unit or in furnace specifications.

11.2 Evaluate ~~the~~ forced-air ~~furnace~~ system(s). Complete a visual inspection of ~~the forced-air furnace~~ appliance(s) and document information as noted in this section.

11.2.1 Document ~~Note~~ condition of the furnace cabinet, removable panels. If panels are loose/missing make recommendation to install/replace/repair.

11.2.2 Document ~~Note~~ condition of return and supply duct connections. If duct connections are not sealed and/or not fastened to the cabinet, make recommendation to install/replace/repair.

11.2.3 Measure the temperature rise of the appliance. Compare the temperature rise to the manufacturer system specifications noted on the appliance. If temperature rise is not within the manufacturer's specified range, recommend that the unit and duct system be evaluated by a qualified professional.

11.2.4 If ~~furnace~~ appliance model(s) allows for condensing operation, check the condition of condensate drain connections, drain line and the condition of the condensate pump if one exists. If no drain line exists, signs of condensate leakage on cabinet are apparent or the condensate pump shows signs of failure such as: the pump reservoir is leaking; the pump or condensate lines are clogged; or the pump is inoperative, rusted, cracked or has suffered mechanical damage, or otherwise appears to be in poor condition, recommend that it be serviced by a qualified professional.

11.3 Evaluate air-conditioning and heat-pump system(s). Complete a visual inspection of ~~the air conditioning and heat-pump~~ appliance(s) and document information as noted in this section.

11.3.1 Examine ~~the~~ outdoor coil cabinet(s).

11.3.1.1 Evaluate the clearance on all sides of the outdoor coil cabinet and document all obstructions to airflow.

11.3.1.2 Evaluate adequacy of clearance above historical average maximum snow depth.

~~11.3.1.2~~ 11.3.1.3 Examine the condition of the outdoor coils. If damage to coils exists and/or debris is blocking the coil passageways, recommend further examination by a qualified professional.

~~11.3.1.3~~ 11.3.1.4 Examine condition of the insulation on the refrigerant piping at the outdoor coil. If it is in poor condition, or no insulation exists, recommend replacement/installation of insulation.

11.3.2 Examine ~~the~~ indoor coil air handler cabinet(s).

11.3.2.1 Check the system filter condition. If no filter exists or it is in poor condition, make recommendation to install/replace.

11.3.2.2 Check for a filter slot cover. If no filter slot cover exists, is in poor condition, or is not well sealed to prevent air infiltration/exfiltration between the HVAC system and the equipment room, make recommendation to install/replace.

11.3.2.3 Check the condition of condensate drain pan connections, drain line and the condition of the condensate pump if one exists. If no drain line exists, signs of condensate leakage on cabinet are apparent or the condensate pump shows signs of failure such as: the pump reservoir is leaking; the pump or condensate lines are clogged; or the pump is inoperative, rusted, cracked or has suffered mechanical damage, or otherwise appears to be in poor condition, recommend that it be serviced by a qualified professional.

11.3.3 Check the integrity of the accessible refrigerant piping insulation in the interior of the building. If no insulation exists on the larger refrigerant ~~refrigeration~~ line or it is in poor condition, recommend that piping insulation be installed/replaced by a qualified professional.

11.3.4 Examine the inside of the air handler cabinet for a dirty blower, ~~and restricted cooling coils.~~ If the blower ~~and/or coils~~ contains dirt buildup, recommend cleaning and servicing by a qualified professional as specified in ~~ANSI/ACCA 6-2007: Restoring the Cleanliness of HVAC Systems~~ ANSI/ACCA 6 QR.[18]

11.3.5 If a centrally ducted whole house humidifier is present, evaluate the function of the unit and recommend that it be set appropriately, repaired by a qualified professional if necessary, or removed if not needed. ~~has been added to the system and is not used, recommend that it be removed and the ducting sealed. If the humidifier has not been used due to operational issues, recommend that it be repaired by a qualified professional.~~

11.4 Evaluate ductless ~~mini-split~~ heat pump(s)/air conditioner(s). Complete a visual inspection of the ~~ductless mini-split heat pump/air conditioner~~ appliance(s) and document information as noted in this section.

11.4.1 Examine ~~the~~ outdoor coil cabinet(s) per 11.3.1.

11.4.2 Examine ~~the~~ indoor air handler cabinet(s) per 11.3.2.

11.4.3 ~~Examine the refrigerant piping insulation per 11.3.3.~~ Check the integrity of the accessible refrigerant piping insulation in the interior of the building. If no insulation exists on the refrigerant lines or it is in poor condition, recommend that piping insulation be installed/replaced by a qualified professional.

11.4.4 Examine the inside of the air handler cabinet(s) per 11.3.4.

11.5 Evaluate packaged terminal air conditioner(s) (PTACs) and heat pump(s) (PTHP). Complete a visual inspection of ~~the packaged terminal air conditioner~~ and PTHP appliance(s) and document information as noted in this section.

11.5.1 Examine the condition and the installation of ~~the~~ PTAC(s) and PTHP(s) ~~packaged terminal air conditioner~~, verifying the condition of the air sealing around the perimeter. If unit is not air sealed or air sealing is in poor condition, recommend installation/repairs.

11.5.2 Check the filter and the accessible surface of the coil for dirt buildup, obstructions or damage and recommend cleaning and repairs.

NOTE: Removable window air conditioners are not within the scope of this standard.

11.6 Evaluate the air distribution system(s). Complete an inspection ~~of the air~~ distribution system(s) and document information as noted in this section.

11.6.1 Visually inspect ducts, plenums and distribution boxes outside the thermal/pressure boundary to check for ~~verify~~ the presence ~~and condition~~ of insulation. If insulation is present, note its condition. In humid climates, check for ~~verify~~ the presence ~~and condition~~ of insulation on metal ducts and plenums located inside the thermal boundary. If insulation is present, note its condition.

11.6.1.1 Note the location and R-value of duct insulation.

11.6.1.1.1 R-value shall meet or exceed the insulation requirements of the AHJ. If no requirement exists, the ducts shall be insulated to R-8 for ducts in vented attics, and in other unconditioned zones, including encapsulated attics and semi-conditioned crawlspaces. Where the R-value of existing duct insulation is insufficient, recommend upgrade.

11.6.1.1.2 In humid climate zones, metal cooling system ducts and plenums located inside the thermal boundary shall be insulated. In other climate zones, duct insulation shall be recommended if there is a possibility that condensation will accumulate on the ductwork. To prevent condensation from occurring on duct work, the minimum insulation R-value installed shall be R-8 and insulation facing seams shall be sealed per manufacturer's instructions. Where insulation is lacking or R-value is insufficient, document deficiencies and recommend upgrade.

11.6.1.2 Verify that insulation is installed with facing exposed, that all seams in insulation facing are mechanically fastened and taped, and that insulation is not compressed to less than 75 percent of original thickness. Document deficiencies and recommend improvements.

11.6.2 Ducts shall be tested for leakage using one of the following methods:

11.6.2.1 Quantitative testing using:

11.6.2.1.1 Methods in accordance with procedures from ~~*ANSI/ACCA 5 QI-2010 - HVAC Quality Installation Specification*~~ ANSI/ACCA 5,[19] Section 5.1 Duct Leakage~~, or~~

~~11.6.2.1.2 Whole house pressurization/depressurization procedure (e.g., Delta Q.) in accordance with the manufacturer's instructions.~~

11.6.2.2 Total duct leakage and/or leakage to outside. ~~Qualitative testing using a gasketed pan in accordance with the manufacturer's instructions and in conjunction with a blower door.~~

11.6.2.1.1 When *quantifying* duct leakage, the leakage rate (as determined in accordance with Section 11.6.2.1. above) shall be indicated as a percentage of the measured or estimated total airflow. Limits shall be in accordance with Section 5.1 of ~~*ANSI/ACCA 5 QI-2010 - HVAC Quality Installation Specification*~~ ANSI/ACCA 5.[18] When these limits are exceeded, duct sealing shall be recommended.

11.6.2.3 Qualitative testing using a gasketed pressure pan in conjunction with a blower door.

~~11.6.3.2~~ 11.6.2.4 When *qualifying* duct leakage as determined in accordance with Section 11.6.2.2 above, if pressure difference exceeds 3 Pa, duct sealing shall be recommended.

~~11.6.3.2~~ 11.6.2.3 When duct sealing is recommended, a recommendation for post-installation total external static pressure measurement by a qualified professional shall be included.[8]

~~11.6.2 If building cavities are used as return air ducts, the technician shall test for duct leakage to the outside.~~

~~11.6.4~~ 11.6.3 Ducts shall be visually and/or diagnostically inspected for restrictions to airflow: When restrictions to airflow are ~~visually~~ identified, recommend that a qualified professional evaluate the air distribution system.

11.7 Evaluate evaporative cooler(s). Complete a visual inspection of ~~the evaporative cooler~~ appliance(s) and document information as noted in this section.

11.7.1 Examine ~~the~~ evaporative cooler(s) exterior housing installation and condition. Evaluate the clearance around the unit and document any rust, corrosion, leakage and ~~all~~ obstructions to airflow.

11.7.2 Document the presence and condition of air-moving equipment (louvers, fan, fan controls, etc). ~~Check the bleed tube or sump pump for the presence of dirty water or clogging.~~

11.7.3 Document the presence and condition of water-moving equipment (sump pump, bleed tube, etc.) ~~Verify that there are no signs of mold or moisture issues with the system.~~

~~11.7.4 Verify the condition of the exterior unit, looking for rust and corrosion.~~

~~11.7.5 Verify that the louvers to the cooler cabinet are clean.~~

11.8 Evaluate ~~steam heating system~~ steam boiler(s) and near-boiler piping. Complete a visual inspection appliance(s) and piping, ~~of the steam heating boiler~~ and document information as noted in this section.

[8] Total external static pressure measurement provides the ability to more effectively prescribe and test the results of duct renovation work. The test also provides some level of assurance that the duct renovation work will not create a premature ~~catastrophic~~ failure of the heating or cooling equipment.

11.8.1 Inspect for evidence of water leakage, buildup of deposits, ~~and/or~~ corrosion, and/or steam or liquid leaks (via visible or infrared inspection) at the appliance ~~and local piping~~ and near-boiler piping. If such evidence is noted, recommend further evaluation and/or repair by a qualified professional.

11.8.2 Check sight glass and note water level and appearance. If no water is present or the water level is at or near the bottom of the sight glass, or if the water is dark in color, recommend that the system be serviced by a qualified professional.

11.8.3 Determine through homeowner/occupant interview and/or checking of the water feeder logger (if available and historical levels have been recorded) if water in excess of the manufacturer's specifications had to be added to or removed from the boiler during the heating season. ~~If water has been added or removed,~~ If this is the case, recommend that the system be serviced by a qualified professional.

11.8.4 Verify the presence and condition of a low water cut-off. If no low water cut-off is present, recommend installation by a qualified professional.

11.8.5 Verify the presence of ~~the~~ a ~~temperature/~~pressure relief ~~(TPR)~~ valve (PRV) and note its rating. Verify the presence of ~~TPR~~ PRV piping and proper termination point (no more than 6 inches above the floor or waste receptor). If ~~TPR~~ PRV ~~valve~~ and/or piping for relief is missing, ~~or~~ the valve ~~is improperly rated~~ does not meet manufacturer specifications for the appliance, or the termination point is more than 6 inches off the floor, recommend installation or repair by a qualified professional.

11.8.6 Inspect for soot, debris, or signs of spillage around flue collar, barometric draft control, or draft hood, if the appliance is equipped with one. If noted, recommend that the system be serviced by a qualified professional.

11.9 Evaluate ~~the~~ steam heating distribution system(s). Complete a visual inspection of appliance(s) and document information as noted in this section.

11.9.1 Examine ~~the~~ insulation on ~~the steam heating~~ appliance distribution piping. Note the insulation type and condition. If friable asbestos-like material is evident, project documentation shall include a recommendation for a qualified professional to verify the presence of asbestos and that procedures follow federal, state and local guidelines for dealing with asbestos. On systems with no insulation or damaged insulation, recommend that piping be insulated with insulation rated for steam piping or to a level meeting the requirements of the AHJ. Note: Intentionally uninsulated pipes used to provide space heating do not require a recommendation for insulation.

11.9.2 Determine through observation or homeowner/occupant interview if unusual noises are heard from the distribution system while the system is operating. If noted, recommend further evaluation by a qualified professional.

11.9.3 Inspect the distribution system for ~~water~~ liquid or vapor leaks. If leaks are noted, recommend repair by a qualified professional.

11.9.4 Inspect for missing or ~~damaged~~ improperly working vents on ~~radiators~~ heat emitters. Note deficiencies and recommend further evaluation/repair by a qualified professional.

11.9.5 Follow lighting instructions for boiler and place in operation. Adjust the thermostat or control so the appliance will operate continuously. Note any ~~radiators~~ heat emitters not producing heat. If any ~~radiator~~ heat emitter does not produce heat, recommend the system be serviced by a qualified professional. Return ~~Place~~ boiler control to previous ~~to original~~ setting.

11.10 Evaluate ~~the~~ forced hot~~-~~ water space heating appliance(s). Complete a visual inspection of ~~the forced hot water space heating~~ appliance(s) and document information as noted in this section.

11.10.1 Inspect for evidence of leakage, corrosion and deposits at the appliance and local piping. If such evidence is noted, recommend further evaluation and/or repair by a qualified professional.

11.10.2 Verify the presence and condition of an automatic feeder valve on all closed systems. If not present, recommend installation by a qualified professional. Determine through homeowner/occupant interview if water had to be added to or removed from the appliance during the heating season. If water was added or removed, recommend that the system be serviced by a qualified professional.

11.10.3 Verify the presence and condition of the ~~TPR~~ PRV and note its rating. Verify the presence of ~~TPR~~ PRV piping. If ~~TPR~~ PRV valve and/or piping for relief valve are missing, or the valve is improperly rated for the appliance, recommend installation by a qualified professional.

11.10.4 Verify the presence and condition of a low water cut-off. If no low water cut-off is present, recommend installation by a qualified professional.

11.10.5 Inspect for soot, debris, or signs of spillage around flue collar, barometric draft control, or draft hood, if the appliance is equipped with one. If any noted, recommend boiler be serviced by a qualified professional.

11.10.6 Note condition of the expansion tank. If it is in poor condition (e.g., corrosion or pitting), recommend further evaluation and/or replacement by a qualified professional.

11.11 Evaluate forced hot- water space-heating distribution system(s). Complete a visual inspection of appliance(s) and document information as noted in this section.

11.11.1 Document the number and location of circulating pump(s) and/or zone valve(s) and location of the thermostat(s)/operating controls for each pump or /zone.

11.11.2 Inspect the fin tubes of the heat emitter(s), if equipped, for built up dust or obvious obstructions. If dust or obstruction are noted, recommend fin tubes be cleaned. Note any closed dampers and discuss with homeowner/occupant.

11.11.3 Inspect the distribution system for water leaks. If leaks are noted, recommend repair by a qualified professional.

11.11.4 Inspect Survey distribution system piping passing through unconditioned spaces for insulation. If no insulation is present, recommend adding insulation to pipes in unconditioned spaces in accordance with AHJ.

11.11.5 Follow lighting instructions and place heating appliance in operation. Adjust the thermostat(s) or control(s) so the appliance and circulator(s) and/or zone valve(s) will operate continuously. Note any heat emitters not producing heat. If any heat emitter does not produce heat, recommend the system be serviced by a qualified professional. Return Place appliance thermostat or control to previous original setting.

11.12 Evaluate the domestic water heater(s). Complete a visual inspection of the water heater appliance(s) and document information as noted in this section.

11.12.1 Note the location, type, and general condition of the domestic water heater(s).

11.12.2 Inspect for soot, debris, or signs of spillage around flue collar, barometric draft control, or draft hood, if the appliance is equipped with one. If noted, recommend water heater be serviced by a qualified professional.

11.12.3 Check for Verify the presence and condition of tank insulation wrap. If tank insulation is installed, verify its condition. If insulation is in poor condition, blocking combustion air on fuel-fired appliances, and/or prohibited by the manufacturer, recommend removal, repair, or replacement accordingly.

11.12.4 ~~Verify~~ Check for the presence and condition of an overflow pan if appliance is located where moisture could cause a problem (e.g., above the ground floor space, in attics or ceiling areas, or within the habitable space). If no overflow pan is present or if it is in poor condition, recommend that a new one be installed.

11.12.5 Document temperature control setting.

11.12.6 Check for ~~Verify~~ the presence of pipe insulation. If pipe insulation is present~~,~~ note~~ing~~ type, location, and condition. If no insulation is present, or if existing insulation is in poor condition, recommend insulation be installed on the first six feet of the hot water pipes.

11.12.7 Check for ~~Verify~~ the presence of the TPR valve and note its rating. Verify the presence of TPR piping. If TPR valve and/or piping for relief valve are missing, or the valve is improperly rated for the appliance, recommend installation by a qualified professional.

11.12.8 Inspect for leaks at ~~the~~ storage tank(s). If leaks are evident, recommend that the appliance be replaced with a high efficiency appliance installed by a qualified professional.

11.12.9 Note condition of expansion tank(s) if present. If in poor condition (e.g., corrosion or pitting), recommend further evaluation and/or replacement by a qualified professional.

12 Baseload Energy Efficiency

The auditor shall comply with the requirements detailed in BPI-1100, Section 12, Baseload Energy Efficiency. In addition, the evaluation of baseload energy efficiency shall be conducted as follows:

12.1 Description of major appliances and plug loads, and recommendations

12.1.1 Record existing refrigerator and freezer model number, date of manufacture, and condition of the coils, seals, and water supply (if equipped). If the model number and date of manufacture cannot be determined, record the type and approximate age ~~for~~ of each appliance. When replacement is recommended, replace with ~~replacement~~ appliances that meet or exceed ENERGY STAR® specifications.

12.1.2 Record type and manufacture date of other appliances such as dishwashers, clothes washers, clothes dryers, dehumidifiers, etc. If the model number and date of manufacture cannot be determined, record the type and approximate age ~~for~~ of each appliance. When replacement is recommended, replace with ~~replacement~~ appliances that meet or exceed ENERGY STAR® specifications.

12.1.3 Record the fuel source and venting of the dryer. Consider replacement ~~of dryer~~ if unit is not equipped with moisture sensing device or if replacing ~~changing~~ would result in cost savings~~. to a less expensive fuel source would result in cost savings~~. Ensure that ~~the~~ exhausting (non-heat-pump) dryers vent~~s~~ to the exterior and ~~is~~ are not constricted with lint. If the dryer is vented with plastic ductwork, recommend replacement with all-metal duct~~s~~.

12.1.4 Record existing ~~high-use~~ lighting energy usage and make recommendations for lighting efficiency, including ENERGY STAR® certified lamps and/or fixtures, ~~compact fluorescent or LED bulbs, and hardwire fluorescent or LED fixtures,~~ where appropriate.

12.5.1 Record existing ~~high-use~~ lighting energy usage and make recommendations for lighting efficiency, including ENERGY STAR® certified lamps and/or fixtures, ~~compact fluorescent or LED bulbs, and hardwire fluorescent or LED fixtures,~~ where appropriate

12.2 Pools, spas,[9] and portable hot tubs

12.2.1 Residential pools or inground spas

12.2.1.1 Record pool and/or spa size (gallons), type, and usage (hours per day and months per year), and existing pump rated horsepower (Hp) [10]

12.2.1.2 Note: Additional guidance for residential pool and spa inspection can be found through the Pool and Hot Tub Alliance (PHTA) Energy Efficiency Compliance Information for Residential Swimming Pools.[20] ~~informative Annex H, ANSI/APSP/ICC 15 Energy Efficiency Compliance Information for Residential Swimming Pools.~~

12.2.1.3 Where not already in place, recommend a variable speed pool pump that meets or exceeds ENERGY STAR® specifications, operation timers, lower water temperature, solar cover for the pool, and thermal cover for the spa. Recommend proper maintenance including cleaning of filters.

12.2.2 Portable hot tubs

12.2.2.1 Verify that the unit is labeled as compliant with minimum standards provided in ANSI/APSP/ICC-14-2019.[21] ~~2011, Standard for Portable Electric Spa Energy~~ If the spa is not labeled, recommend replacement with an ASPS/ICC-14-compliant unit.

12.2.2.2 At a minimum, ensure a tight-fitting and well-insulated cover to minimize heat loss. If existing insulating cover has become waterlogged, recommend replacement.

12.3 Record the number of sump, septic, ~~and~~ well pumps, and other liquid pumps on the property. During client interview, ask if the client has experienced any characteristics of poorly operating pumps, such as short cycling, unusual odors, or low water pressure. Recommend further investigation or replacement, if applicable ~~relevant~~.

12.4 Estimate the baseload energy usage

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[9] ~~Swimming pools, spas, and hot tubs can use large amounts of energy and greatly skew household baseload use if not accurately accounted for.~~ Pools, spas, and portable hot tubs can consume large amounts of water and are covered in Annex E. Similar data is collected and used in evaluating the water features water use.

[10] These minimal parameters allow reasonable estimates of existing pool energy use and readily achievable savings when entered into home performance software and savings calculators such as the ENERGY STAR® Pool Pump Calculator at www.energystar.gov/products/certified-products/detail/pool-pumps.

12.4.1 Estimating the baseload energy usage by using software

12.4.1.1 The auditor may use software that complies with ~~ANSI/~~BPI-2400 to estimate baseload for homes with any fuel type.

12.4.1.2 Exception: When using software that does not fully comply with ~~ANSI/~~BPI-2400, the auditor shall ensure that at a minimum, the practices in ~~ANSI/~~BPI-2400, Section 3.2.1 C.a.ii (detailed) or 3.3.1 (calculation of Normalized Annual Baseload Use) are implemented.

Note: Software baseload estimation is the preferred method. Software that complies with ~~ANSI/~~BPI-2400 will provide a much more accurate base, heating, and cooling estimate than manual methods.

12.4.2 Estimating the baseload energy usage ~~from~~ by measuring energy use

12.4.2.1 In homes with grid-connected, meter-read fuel (natural gas or electricity), and where at least 12 consecutive monthly energy bills are available, the auditor may use the following method:

12.4.2.1.1 Calculate the annual natural gas baseload by averaging three lowest months' therms and using the following formula:

Annual gas baseload = 12 x 1.1 x (average of three lowest months' therms)

12.4.2.1.2 Calculate the annual electric baseload by averaging the three lowest months' kWh and using the following formula:

Annual electricity baseload = 12 x 1.1 x (average of the three lowest months' kWh)

Note: for homes with electric heating and cooling, if the HVAC controls are set to provide automatic heat/cool changeover on demand, even the lowest month kWh reading may overestimate baseload and should be considered on a case-by-case basis. Similarly, in mild climates with a very long or year-round pool season, space heating and pool operation may overlap, resulting in overestimate of baseload.

12.4.2.2 In homes with non-metered fuel (such as home heating oil and LP gas), collect at least 12 months of fuel delivery records. If the tank is not regularly filled to capacity, then baseload cannot be established by this method. If the tank is regularly filled to capacity, then create a timeline with the date and amount of fuel delivered. Use each delivered quantity and the time span between deliveries to calculate a per month average for each delivery and create a 12 month usage data set. The amount used during the warmest three months of the year, averaged over the rest of the year, multiplied by 1.1, is baseload. Use the following equation: 12 x 1.1 x (average of the three lowest months of gallons used) = baseload. Note: The degree of uncertainty in establishing non-grid connected baseload increases as the number of fuel delivery records decreases.

13 Water Conservation

13.1 The evaluation ~~shall~~ may include an assessment of potential water conservation measures based on the ~~following observations.~~ requirements detailed in Annex E.

~~13.1 Record existing quantity and type of shower heads, toilets, faucets, etc. Determine if shower heads and toilets are low-flow or efficient devices. Determine if faucets are low flow or are equipped with aerators or water conserving design (for example, touch faucets or "WaterSense®" equipped). Note any observed water leaks from plumbing fixtures or leakage at toilet flapper valve/s in project documentation.~~

~~13.2 If home is equipped with old style clothes washer, recommend replacement with an appliance that is equipped with water conserving technology and meets or exceeds ENERGY STAR® specifications.~~

~~13.3 If landscape irrigation is in place, record months, days and hours it is used. Recommend water conservation methods (such as rain sensors, timers, or WaterSense® equipment).~~

~~13.4 Inspect exterior plumbing components. Note leaking faucets and hose bibs and recommend repair or replacement.~~

Annex ~~F~~A | Homeowner/Occupant Questionnaire (Informative)

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

The Homeowner/Occupant Questionnaire provides a list of sample questions and information on household energy behavior, building performance, and possible health and safety issues. This interview may be conducted in person, by phone, by e-mail, or by any other means convenient for the homeowner/occupant. This document ~~is to be completed by the auditor.~~ can be used by an administrative intake individual or completed by the auditor.

1. How long have you lived here?

2. Was the home built prior to 1978?

~~2.~~ 3. How many adults reside in the home?

~~3.~~ 4. How many children reside in the home?

~~4.~~ 5. What type of heating system do you have?

   a. Fuel type?

   ~~b. Cost per unit of fuel?~~

   b.~~c.~~ How old is the heating system?

   c.~~d.~~ When was the last service/clean and tune?

~~5.~~ 6. Forced ~~Air~~ air ~~F~~furnace~~s~~

   a. Do you regularly change your furnace (or central A/C) filter?

   b. Date of last filter change?

~~6.~~ 7. Steam ~~Heating~~ heating ~~Boiler~~ boiler

   a. ~~Have you had to add more than a small amount of water to the boiler during the heating season?~~ How often do you add water to the boiler during the heating season?

~~7.~~ 8. Steam ~~Heating~~ heating ~~Boiler~~ boiler ~~Distribution~~ distribution ~~System~~ system

   a. Do all radiators get hot?

   b. Does the pressure relief valve ~~discharge~~ leak?

c. Do you hear loud banging noises from the radiators or pipe(s)?

~~8.~~ 9. Forced hot~~-~~ water space-heating appliance (boiler)

a. Do all radiators get hot?

b. Does the pressure relief valve ~~discharge~~ leak?

c. Does the system need to be bled periodically?

~~9.~~ 10. Do you use other appliances for comfort heating?

a. What type?

b. Fuel type?

c. Location in the house?

~~10.~~ 11. Do you have a working fireplace, woodstove or pellet stove?

a. How often do you use it?

b. How often is the flue cleaned?

c. How often is the fireplace, woodstove or pellet stove cleaned?

~~11.~~ 12. What type of fuel is being used?

a. Where do you store the wood or pellets?

b. How much fuel did you use during the last heating season?

c. Are there issues, such as excessive smoking or staining, when the fireplace, woodstove or pellet stove is in use?

~~12.~~ 13. Do you have the owners' manual or installation guide for the appliance?

~~13.~~ 14. Does your home have cold rooms or areas?

a. Where and when does this occur?

~~14.~~ 15. Does your home have rooms or areas that are too warm?

a. Where and when does this occur?

~~15.~~ 16. Are there drafty areas in your home?

a. Where and when does this occur?

~~16.~~ 17. Thermostat ~~type~~ number, type(s), and location(s)?

a. What is the highest setting you use?

b. What is the lowest setting you use?

~~17.~~ 18. Do you close off any rooms to prevent heating them?

~~18.~~ 19. Do any occupants suffer from headaches, flu, colds, or nausea during the heating season?

~~19.~~ 20. Is there a known moisture or condensation problem in the home?

a. Where and when does this occur?

~~20.~~ 21. Is there any known mold/mildew issue in your home?

a. Where and when does this occur?

~~21.~~ 22. Are you aware of lead paint or asbestos in your home?

~~22.~~ 23. Has your home been tested for radon?

~~23.~~ 24. Does the basement get wet at any time during the year?

~~24.~~ 25. Have you experienced any evidence of poorly operating pumps, such as short cycling, unusual odors, or low water pressure?

~~25.~~ 26. Does ice form on the eaves or in the attic during winter?

~~26.~~ 27. Does your roof leak during any time of the year?

~~27.~~ 28. Do you have an air conditioner?

~~28.~~ 29. Are there windows or doors that are hard to open or close?

~~29.~~ 30. Are there any known electrical issues (e.g., knob and tube wiring)?

a. Do all the lights and outlets work?

b. Can you turn on multiple appliances at the same time?

c. Are there any lights that flicker?

~~30.~~ 31. How many loads of laundry do you wash/dry per day (or week)?

~~31.~~ 32. Approximately how many showers/baths per day?

~~32.~~ 33. Do you have functioning smoke alarms?

a. How many?

b. Where are they located?

~~33.~~ 34. Do you have functioning CO alarms?

a. How many?

b. Where are they located?

~~34.~~ 35. Are there specific health and safety or comfort issues you would like to discuss?

~~35.~~ 36. Are there any major renovations, such as additions, remodeling kitchens or bathrooms, finishing of basement or attic, planned in the next 12 months?

Annex ~~J~~B | Alternate Procedure for Solid Fuel Burning Appliance Inspection (Informative)

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

Per Section ~~7.10.2~~ 7.10.4.1 of this standard, the auditor may opt to conduct the following visual inspection of the appliance and the venting system for indicators that a recommendation should be given to the homeowner/occupant to call in a trained hearth professional with either National Fireplace Institute (NFI) Woodburning or Pellet Certification, or Chimney Safety Institute of America (CSIA) Certification. The inspection of the wood burning or pellet burning appliance or insert is a basic visual inspection and is not designed to diagnose problems or deficiencies with the system. The inspection procedure is as follows:

B~~J~~.1. Identify the listing nameplate on the appliance and verify the model name and model number correspond to the manual. If the appliance listing nameplate is damaged (e.g., painted over, faded, scratched, burnt) and cannot be read, a copy of the nameplate from ONLY the original installation manual may be used and the installation shall also be verified in reference to *NFPA 211*.[22] [(11)]

B~~J~~.2 Obtain the original manufacturer's installation manual from the homeowner/occupant or the manufacturer. If the original installation manual is not available, contact the manufacturer for an exact copy which is relative to the serial number listed on the appliance, or locate the listing nameplate and use this as your installation guide.

B~~J~~.3 Appliances shall be inspected for compliance with manufacturer's listed application.

B~~J~~.4 If so equipped, the system shall be unplugged from its power source during the inspection.

B~~J~~.5 Inspect the venting system for proper vent type and horizontal pitch.

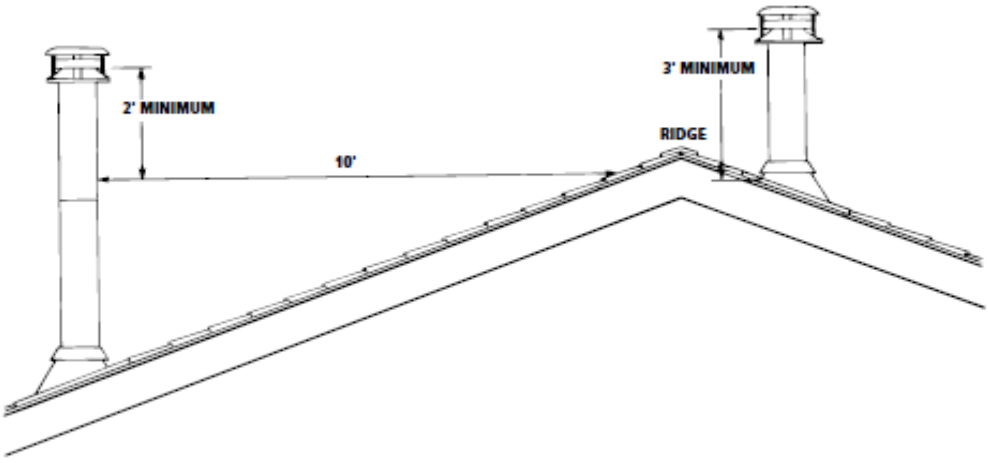
[(11)] NFPA 211 defines certain types of installations but does not necessarily approve installation types.

BJ.6 Inspect the venting system for blockage or restriction, leakage, corrosion, unusually small vent connectors or other deficiencies that could cause an unsafe condition. If one of these conditions exists the auditor shall recommend a certified professional verify the installation and the venting system are appropriate for the appliance, as specified in the manufacturer's installation manual or listing nameplate.

BJ.7 When inspecting a pellet stove, a visual inspection from the ground shall be conducted outside of the home for all horizontal installations to make sure the venting conforms to the manufacturer's recommendations and that vegetation growth is not a hazard or in suspicion of becoming a hazard during the growth seasons.

BJ.8 When inspecting a wood burning appliance, a visual inspection from the ground shall be conducted outside of the home for all vertical installations to make sure the venting conforms to the manufacturer's recommendations and *NFPA 211*, to the extent that the auditor can make an inspection of this area. The venting system must meet the 3:2:10 minimum termination height above roof guideline, as shown in Figure 1 below.

Figure 1: Minimum Chimney Height Requirements



MINIMUM CHIMNEY HEIGHT REQUIREMENTS (THE 3-FOOT, 2-FOOT, 10-FOOT RULE)

BJ.9 All of the system's (system includes appliance and venting) clearances to combustibles shall be visually inspected, inside and outside of the home. This shall include clearances of wood trim, walls, furniture, drapes, ceilings, overhangs, flooring, etc. defined by the appliance listing.

BJ.10 Visually inspect the type and condition of flooring material where the

appliance is installed. Appliances installed on carpet or wood floors fail unless equipped with a factory-supplied hearth. Hearth boards or pads used under appliances shall be listed, however; the listing details may be under the hearth itself and not readily accessed.

BJ.11 Mechanical areas of the appliance shall be inspected for visual signs of wear or malfunction to components, however, a removal of the components is not required.

BJ.12 A recommendation for service by a qualified professional or a recommendation for replacement of the appliance shall be made if any of the following indicators are noted:

BJ.12.a Excessive buildup of ash deposits

BJ.12.b Excessive buildup of creosote within any portion of the venting, combustion motor, heat exchanger or firebox evident through a visual inspection

BJ.12.c Appliances installed on carpets, wood floors or other combustible materials

BJ.12.d Inadequate clearance to combustible materials

BJ.12.e Signs of structural failure, such as cracks or broken welds, of any components

BJ.12.f Evidence of blockage, restriction, leakage, corrosion, flame roll-out, and other deficiencies that could cause an unsafe condition

BJ.12.i Any venting conditions that do not comply with the manufacturer's recommendations or *NFPA 211.*

BJ.13 Project documentation shall indicate any conditions deemed to be unsafe.

BJ.14 When air sealing or insulation measures are recommended in a home with a fireplace insert, prescribe the installation of a fireplace insert liner (attached to the insert, not the existing fireplace liner) if an existing insert liner is not in place.

Annex ~~I~~C | Determining Ventilation Requirements (Informative)

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

The following information is provided to assist the user of this standard in complying with the requirements of ~~*ANSI/ASHRAE 62.2-2013: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.*~~ ANSI/ASHRAE 62.2~~-2013~~ 2025.[11]

C~~I~~.1 Determine the ventilation requirements as outlined in the following section.

C~~I~~.1.1 Determine the required whole-building ventilation rate. Calculate the whole-building mechanical ventilation requirement using the approach in ~~*ANSI/ASHRAE 62.2-2013: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential* (~~ANSI/ASHRAE 62.2-~~2013~~ 2025~~)~~,[11]~~ Section 4. The nominal fan size to provide continuous airflow in ~~cubic feet per minute (~~CFM~~)~~ is based on the number of bedrooms and the conditioned floor area of the home. Determine the minimum required flow rate in CFM (based on continuous operation) using this formula;~~ [12]

$$Q_{tot} = (0.03 \times \text{conditioned floor area}^{[13]}) + (7.5 \times (\text{number of bedrooms} + 1))$$

C~~I~~.1.2 Determine the required local ventilation for each kitchen and for each full bath (any bathroom including either a tub, shower or sauna) as follows:

C~~I~~.1.2.1 Each kitchen shall have a demand-controlled[14] exhaust fan that operates at a minimum of 100 CFM and each bath shall have a demand-controlled exhaust fan that operates at a minimum of 50 CFM (unless the alternate path specified in I.1.3.1 is used).

C~~I~~.1.2.2 Measure the flow rate of any existing kitchen and bath fan(s) that exhaust to outdoors.

C~~I~~.1.2.3. For each kitchen and bath, determine the shortfall by subtracting the measured flow from the required flow rate.

C~~I~~.1.3 For each kitchen and bath, any shortfall in the existing ventilation flow may be addressed by adding a new fan, replacing an existing fan, upgrading the fan or ducts to increase flow, or supplementing it with another fan.

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[12] The ANSI/ASHRAE 62.2-~~2013~~ 2025 Standard also includes a table; use of the table is accepted, but may lead to higher ventilation requirements.
[13] Conditioned floor area is defined in ANSI/ASHRAE 62.2-2025, Section 3.
[14] ANSI/ASHRAE 62.2-~~2013~~ 2025 refers to demand-control as “designed to be operated as needed by the occupant.”

Cl.1.3.1 *Alternate:* For previously occupied buildings, the alternative compliance path specified in ANSI/ASHRAE 62.2-~~2013~~ 2025*: Appendix A*, may be used to address a shortfall in local exhaust flow(s). If Appendix A is used, the required whole-building flow rate Q_{tot}, shall be adjusted and any existing fans may be left in place. If chosen, apply the alternative compliance path as follows:

Cl.1.3.1.1 For any kitchen or bathroom with an operable window (regardless of how many), 20 CFM may be subtracted as a credit against the shortfall.[15] The result is referred to as the local exhaust *deficit* for that room. The 20 CFM credit applies to each kitchen or bathroom independently; an operable window can only reduce the CFM requirement for the room containing the window. For each room, the deficit shall not be less than zero.

Cl.1.3.1.2 Total the deficits of all kitchens and baths for which Appendix A will be used, and divide the result by 4. This is the alternative compliance *supplement*.

Cl.1.3.1.3 Add the final supplement in CFM to the required whole-building continuous ventilation rate, Q_{tot}. For example: A house has an existing kitchen fan with a measured flow rate of 50 CFM, and an operable window exists in the kitchen. The house has one bathroom with no window, and a measured flow rate of 40 CFM. The deficit is (100 - 50 - 20) + (50 - 40) = 40 CFM. The supplement to the whole-building requirement is 40 ÷ 4 = 10 CFM. Thus 10 CFM would be added to the whole-building ventilation rate, Q_{tot}.

Cl.1.3.1.4 The alternative compliance supplement shall be added to the whole-building ventilation rate, Q_{tot}, *before* the infiltration credit Q_{inf} (calculated as outlined in the following section) is subtracted.

Cl.1. 4 Infiltration Credit: Q_{tot} may be further adjusted if a blower door test has been performed.

Note: This credit shall be based on the final blower door test result upon completion of any air sealing completed in the dwelling. The following formula can be used to determine the infiltration credit. [16]

$$Q_{inf} = 0.052 * Q_{50} * S * wsf * A_{ext}$$

~~$Q_{inf} = 0.052 \times Q_{50} \times S \times wsf$~~

[15] To use this reduction, the AHJ must consider windows an acceptable ventilation method.
[16] This computation is derived from combining equations 4.2, 4.4 and 4.5a, and yields equivalent results. Spreadsheets, smart phone applications, and computer software are also available to make these calculations.

Where:

A_{ext} = 1 for detached *dwelling units*; otherwise, for horizontally attached *dwelling units*, the ratio of *dwelling-unit boundary area* that is not attached to garages or other *dwelling units* to total *dwelling-unit boundary area*

Q_{inf} = Infiltration credit in CFM

Q_{50} = blower door measurement[17]

S = Story factor

wsf = weather and shielding factor for nearest weather station from (ANSI/ASHRAE 62.2-~~2013~~ 2025)[11]: Appendix B

Number of Stories	Story Factor (S)
1	1
1.5	1.18
2	1.32
2.5	1.44
3	1.55

For existing buildings, $\mathbf{Q_{fan} = Q_{tot} - Q_{inf}}$

Where:

Q_{fan} = required mechanical ventilation rate, CFM[18]

Q_{tot} = Total required ventilation rate, CFM (including any alternative compliance supplement added in accordance with Section C~~l~~.1.3.1)

C~~l~~.2 After adjusting the whole-building ventilation requirements for local ventilation deficits and infiltration credits, and accounting for existing conditions in the home, determine one or more design strategies that can provide the amount of whole-building ventilation needed, as follows:

[17] BPI allows the use of a single-point blower door test to determine this value, provided the local AHJ permits the single-point test.

[18] Per ANSI/ASHRAE 62.2-~~2013~~ 2025 Draft Addendum B: If QFAN is less than 15 CFM, no additional whole house ventilation is needed.

C~~l~~.2.1. The system shall consist of one or more exhaust or supply fans, balanced fans, heat or energy recovery ventilators, or outdoor air ducts supplied to the return side of the air handler if the manufacturer's requirements for return air temperature are met. Local exhaust fans such as a bathroom or kitchen fan may be used as the whole-building ventilation system. [19]

Note: If a bathroom exhaust fan is operated continuously to satisfy the whole-building ventilation rate, the air flow requirement for that bath fan shall be reduced from 50 CFM to the whole-building rate, or to 20 CFM, whichever is larger.

C~~l~~.2.2 The whole-building ventilation system may run intermittently, but the fan flow rate shall be adjusted. As long as the fan and controls provide the required average CFM at least once in every three hour period, the delivered flow rate is simply the actual fan flow rate times the fractional on time. For example, if 50 CFM is needed to satisfy Q_{fan}, a 100 CFM fan that runs 30 minutes per hour meets the requirement. If cycle times are longer than three hours (including both on- and off-periods), the flow rate in CFM shall be adjusted in accordance with ANSI/ASHRAE 62.2-~~2013~~ 2025, Section 4.5.2.

C~~l~~.2.3 The system shall have a readily accessible and appropriately labeled override switch that allows homeowner/occupants to suspend normal system operation.

C~~l~~.2.4 Ventilation products must be tested and certified for airflow and sound level in compliance with ANSI/ASHRAE Standard 51/AMCA 210,[23] ANSI/AMCA Standard 210-~~07~~16,[24] ANSI/ASHRAE 51-~~07~~16:[25] ~~Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating~~ and rated in accordance with the airflow and sound rating procedures of the Home Ventilating Institute (HVI) and they must carry a certification label such as HVI. (Label should be visible inside the housing.)

C~~l~~.2.5 Newly installed local exhaust fans that run continuously and all whole-building ventilation fans shall have a sound rating of 1.0 sone or less.

Exceptions: remotely mounted fans or systems utilizing a central air handler fan have no sound rating requirement.

C~~l~~.2.6 Newly installed local exhaust ventilation systems that are not run continuously shall have a sound rating of 3.0 sones or less.

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[19] If a local exhaust fan is to be upgraded to a higher flow rate as part of the recommended design, and the post-upgrade flow rate meets the requirements for that room, any deficit based on the pre-existing fan need not be included in the deficit total determined in Section C~~l~~.1.3.1.

Exceptions: remotely mounted fans or fans with a maximum rating of at least 400 CFM have no sound rating requirement.

C~~I~~.3 Ventilation system testing for airflow shall be recommended after installation.

C~~I~~.3.1 Testing may be done with a flow hood, flow grid, or other flow measuring device. (For example, a flow box with a calibrated opening connected to a manometer can be used to measure exhaust flows.)

C~~I~~.3.2 Verify that each newly installed, upgraded or modified local exhaust fan provides the CFM airflow required as determined in Section C~~I~~.1.3.

Annex D | Action Levels for Spillage and Carbon Monoxide in Combustion Appliances (Normative)

D.1 Spillage assessment and CO measurement (as shown in Table D.1.A) results shall be based on the following criteria:

- ~~CO measured at 5 minutes of main burner operation~~
- ~~Spillage assessed at 2 minutes of main burner operation for warm vent~~
- ~~Spillage assessed at 5 minutes of main burner operation for cold vent~~
- Spillage assessed up to 5 minutes of main burner operation
- CO air free measured at 5 minutes of main burner operation
- CO level at or below threshold in Section ~~7.9.5, Table 1~~ 7.9.7.3 for the appliance being tested is ACCEPTABLE
- CO level exceeding threshold in Section ~~7.9.5, Table 1~~ 7.9.7.3 for the appliance being tested is UNACCEPTABLE

TABLE D.1.A ACTION LEVELS FOR SPILLAGE IN COMBUSTION APPLIANCES **The following actions shall be taken when spillage occurs under the specific circumstances detailed below.**	
TEST RESULT	ACTION REQUIRED (IN ORDER)
Greatest CAZ depressurization occurs with the air handler on*	Conduct further analysis of the distribution system to determine if ~~leaky ducts~~ duct leakage or other HVAC-induced imbalances are the cause of the spillage. If so, recommend distribution system repairs that will reduce or eliminate the CAZ depressurization.
Greatest CAZ depressurization occurs with door to CAZ closed, but is alleviated when door to CAZ is open*	Recommend measures to improve air transfer between the CAZ and the core of the house.
The cause of spillage has been traced to excessive exhaust** independent of CAZ door position, air handler, or a problem with the flue.†	Verify that sufficient combustion air is available per ANSI Z223.1/NFPA 54[6] for gas-fired appliances and NFPA 31[26] for oil-fired appliances or recommend verification by a qualified professional, and/or Recommend further evaluation/service by a qualified professional to address the venting/combustion air issues.
***In the case where both spillage and excessive CO are present, in addition to the specific recommendations above, recommend that the appliance be shut down until it can be serviced by a qualified professional.** ** Refers to exhaust caused by mechanical ventilation and/or other means of exfiltration. †When a recommendation to replace atmospherically-vented combustion equipment inside the pressure boundary is made, and when cost-effective, recommend replacement with direct-vented, or power-vented equipment (or non-combustion equipment, such as a heat pump), which is ENERGY STAR®-labeled.	

TABLE D.1 B. ACTION LEVELS FOR CO IN COMBUSTION APPLIANCES	
TEST RESULT	ACTION REQUIRED
Unacceptable CO level	Advise the homeowner/occupant that the appliance should be serviced immediately by a qualified professional. Note: If ambient CO levels do not exceed 70 ppm, testing of other appliances and other audit procedures may continue at the discretion of the auditor
Acceptable CO level	No action required.

Annex E | Water Efficiency Assessment of Single-Family Dwellings (Normative)

E.1 Scope

E.1.1 This annex defines the minimum criteria for conducting a building science-based residential whole-building water efficiency assessment.

E.1.2 The assessment shall include an audit that will address water usage and limited aspects of building durability, occupant comfort, health and safety. The audit report will provide a comprehensive list of prioritized recommendations to improve the water efficiency of the home. The audit report will include a cost-benefit analysis of the prioritized recommendations.

E1.3 This annex supplements the energy audit procedures of BPI 1200, and are considered normative (required) when adopted.

E.2 Preparing for the Audit

E2.1 Homeowner Education and Communication

E2.1.1 This section provides guidance to support occupant and homeowner education and communication related to water efficiency and conservation during the home audit process.

E2.1.2 The guidance is intended to promote clear and effective communication and to support informed decision-making related to water use, energy use, comfort, and overall home performance.

E2.1.3 Occupant and Homeowner Education and Communication Across the Audit Process

E2.1.3.1 Education and communication related to water efficiency and conservation should occur throughout the audit process and be integrated into each phase of the audit.

E2.1.3.2 Initial Contact and Pre-Audit Activities

E2.1.3.2.1 During initial contact and pre-audit activities, auditors should:

- Establish an understanding with the homeowner on goals of the audit, procedures and process, priorities, and their concerns.
- Encourage occupant and homeowner participation in identifying concerns related to water use and home performance.

- Communicate, as appropriate, the relationship between water use, energy use, comfort, and operating costs.

E2.1.3.2.2 Occupant and Homeowner Interview

E2.1.3.2.3 The audit shall include an interview with the homeowner/occupants to understand their goals, priorities, and any potential limitations or barriers to implementing water efficiency measures. As part of the audit interview, auditors should:

- Ask questions related to occupant and homeowner water-use behaviors, irrigation schedules, and routines that may affect water and energy use.
- Document concerns related to water use, comfort, or system operation.
- Use clear, non-technical language and avoid using industry acronyms or assigning blame.
- Use open-ended questions to encourage discussion and water use practices, routines, and experiences.

E2.1.3.2.4 See Section H8 for a recommended homeowner questionnaire.

E2.1.4 Common Communication Challenges

E2.1.4.1 Auditors should be aware of communication challenges that may reduce the effectiveness of occupant and homeowner education, including:

- Use of technical terms without explanation or relevancy.
- Overemphasis on estimated savings without behavioral context and cost.
- Inconsistent messaging between verbal communication and written reports.
- Providing too much information and overwhelming the occupant or homeowner, which may limit understanding or action.

E2.2 Visual Inspection, Diagnostic Activities, and Observations

E2.2.1 During visual inspections and diagnostic activities, auditors should:

- Communicate the purpose of procedures or tests related to water use, when applicable.
- Share observations in real time, when appropriate, to support occupant understanding. Photograph observations for report.
- Disclose when urgent water-related health, safety, or damage risks are observed.
- Explain observed conditions in terms of potential impacts on water use, energy use, and overall home performance.

- Communicate uncertainty or restrictions when conditions cannot be fully evaluated during the audit.

E2.3 Recommended Equipment List

E2.3.1 To conduct the inspection, auditors will need the following pieces of equipment:

- Stopwatch
- Digital thermometer, such as a digital food thermometer or infrared thermometer
- Pressure gauge
- Bucket or flow bag with volume measures marked
- Dye tablets for toilets
- Flashlight
- Digital camera
- Tape measure

E3 Cost-Benefit Analysis

E3.1 A cost-benefit analysis shall be included in the audit. The auditor shall make every effort to obtain records of previous water usage as detailed in utility histories.

E3.2 The cost-benefit analysis shall include an analysis of available water consumption records to validate estimates of water savings from the recommended water efficiency measures.

E3.3 A cost-benefit analysis shall include projected water savings associated with the recommended water efficiency measures.

E3.4 Savings estimates shall clearly indicate whether savings are projected for indoor, outdoor, or total household water consumption.

E3.5 The cost-benefit analysis may be presented in terms of reduced water usage, reduced water costs, a fractional performance improvement over existing performance, or an improvement on a relative scale or benchmark such as a water rating index.

E3.6 A cost-benefit analysis shall be completed using one of the following methods:

E3.6.1 A software approved for use with a U.S. EPA WaterSense® Home Certification Organization's WaterSense® Approved Certification Methodology.

E3.6.2 Building water simulation software that shall at a minimum meet the following requirements:

E3.6.2.1 Be capable of analyzing water use for the type of building being evaluated (i.e., single-family or multi-family).

E3.6.2.2 Be capable of reporting water consumption separately for indoor and outdoor water use.

E3.6.3 Generally accepted engineering estimates.

E4. Developing and Prioritizing Recommendations

E4.1 The objective of the prioritized recommendations is to optimize water efficiency measures cost effectively, while maintaining or improving health and safety, occupant comfort, building durability, and satisfying homeowner, occupant, or program objectives.

E4.1.1 When developing recommendations, auditors should:

- Distinguish between user-controlled changes, maintenance actions, and equipment or system improvements.
- Prioritize water efficiency and conservation measures in a manner consistent with occupant and homeowner goals and constraints.
- Explain the value of water-saving behaviors and measures, including interactions with energy use.
- Present numerous options and next steps, in a way that supports informed decision making and homeowner priority.

E4.2 The audit report shall include the following:

E4.2.1 The homeowner/occupant's stated priorities.

E4.2.2 A list of water-related health and safety issues identified during the assessment within the scope of this annex.

E4.2.3 A list of water efficiency measures according to the requirements of this annex and prioritized according to the hierarchy established in E4.1. Water efficiency measures can also include information on potential electricity, natural gas, or other fuel savings.

E4.2.4 The recommended water efficiency measures by the auditor shall be ranked by either projected annual water savings or cost savings. Regardless of ranking criteria, both water and cost savings shall be indicated, as well as how the measures are aligned with the homeowner’s priorities.

E4.2.5 A list of any available rebates or incentive programs offered by the local utilities.

E4.3 Audit reports and related verbal communication should:

- Present water efficiency and conservation information using clear, plain language.
- Clearly identify user-controller changes and behaviors versus actions that will require purchases and contractors.
- Use simple formatting and photos to improve readability.
- Identify and structure action items by prioritized recommendations and homeowner concerns/goals
- Avoid introducing new or unexpected recommendations without explanation.
- Reference applicable programs, incentives, or regulations.
- Invite follow up questions, communications, and long-term goals tracking.
- Provide contact information for follow-up questions.

E5. General Water System Assessment

E5.1 The auditor shall assess all the water metering devices (i.e., meters) installed throughout the building and property for the following:

E5.1.1 Locate the water meter(s) for the site and note the location. Determine and note if there is a single meter for the site to quantify both indoor and outdoor water uses, or if a dedicated irrigation meter is present. If a water meter for irrigation is present, locate and note its location. Repeat steps E5.1.2 through E5.1.6 for all water meters.

Note: Before opening the water meter, determine if local code permits the auditor and/or homeowner to open the water meter or if this can only be performed by utility personnel. If it is permissible to open the meter, continue below.

E5.1.2 Note any visible water leaks at the meter.

E5.1.3 Note the type and size of the meter(s).

E5.1.4 Note if the meter(s) is remotely monitored or has an analog or digital display.

E5.1.5 Note the units of measurement displayed on the meter.

E5.1.6 Watch the meter display for thirty (30) seconds to determine whether the meter is running. If meter indicates water is running, determine if there is water running anywhere else on the property, both indoors and outdoors, and shut off those sources of running water. Once no water is running, measure the change in units displayed on the meter for a two-minute period. Any movement of the flow indicator when all known water uses are off shall be recorded as a leak.

E5.2 Water Use Monitoring

E5.2.1 Through research into the water service provider, determine whether the water meter is part of advanced metering infrastructure (AMI) network and whether an online portal is available for account owners to monitor water use and sign up for leak alerts.

E5.2.2 Water Use Monitoring Recommendations

E5.2.2.1 Where an AMI water meter is installed and online portal is available, the auditor shall recommend that the occupant sign up for water data access and leak alerts.

E5.2.2.2 Where AMI water meter is not installed or an online portal is not available to the occupant, the auditor shall consider recommending that an external or in-line flow monitoring device with leak detection be installed.

E5.3 Main Water Shut-off Valve

E5.3.1 The auditor shall locate all master (primary) water shut-off valves for the building and property for the following:

E5.3.1.1 Locate the master (primary) shut-off valves and note the location.

E5.3.1.2 Note any visible water leaks at the shutoff valve.

E5.3.1.3 For water shutoff valves, the auditor shall note any gate valves (which have circular handles requiring multiple turns) and recommend these be replaced with ball valves (requiring only a quarter turn), which are more reliable.

E5.4 Service Pressure and Leak Test

E5.4.1 The auditor shall use a water pressure gauge to evaluate building water pressure and determine the presence of leaks, as follows.

Note: For homes with separate water supply for indoor versus irrigation water use, separate pressure tests will be needed for each supply. The indoor supply shall be taken on the cold-water faucet for the washing machine hookup or other cold-water faucet. The outdoor/irrigation supply shall be taken using an outdoor hose bib. If using hose bib attached to the building, test to make sure it is on the outdoor water supply by running water and confirming use at the irrigation meter. Section G6 contains additional information on pressure and leak tests for irrigation systems.

E5.4.1.1 Attach a pressure gauge to an outdoor hose bib, the cold-water faucet for the washing machine hookup, or other cold-water faucet. Note the water pressure reading.

E5.4.1.2 Using the main water shut-off valve, turn the water to the building off. After 10 minutes, take another pressure gauge reading. If a loss of water pressure is recorded, it indicates the presence of a leak which shall be further investigated and/or reported to the occupant.

E5.4.2 Service Pressure Recommendation

E5.4.2.1 If the recorded pressure is greater than 80 pounds per square inch (psi), the auditor shall recommend that an existing pressure reducing valve (PRV) be adjusted or replaced. If the building does not include an existing PRV, the auditor shall recommend that one be installed and set to a pressure between 60 to 75 psi.

E5.4.2.2 Refer to the recorded pressure when evaluating faucet and showerhead flow rates. Flow rates for faucets are rated at 60 psi. Flow rates for showerheads are rated at 80 psi. Recommend the use of pressure-compensating flow regulators to provide more consistent flow rates over a wide range of operating pressures.

E6. Indoor Water Assessments

E6.1 Indoor Water Distribution Systems

E6.1.1 The auditor shall assess the indoor water distribution systems serving the building. The intent of this section is to characterize the condition, configuration, and performance of indoor water distribution components, identify visible leaks and maintenance issues, and document factors that may affect indoor water consumption, water waste, occupant comfort, health and safety, or building durability.

E6.2 Hot Water Delivery Structural Waste

E6.2.1 Two types of hot water delivery systems are found in dwellings: those without recirculation loops and those that have them.

E6.2.2 For hot water delivery systems that do not have recirculation loops, the auditor shall determine the volume of water that comes out of the hot water delivery system while occupants wait for hot water to arrive at the point(s) of use furthest from the water heater. The intent of this

assessment is to identify opportunities to reduce the waste of water, energy, and time associated with waiting for hot water. This evaluation is not intended to verify system design compliance or require modification of plumbing systems.

E6.2.2.1 Where possible, the auditor should ensure that hot water has not been used for several hours prior to the test.

E6.2.2.2 Identify the hot water using faucet or showerhead farthest from the water heater.

E6.2.2.3 First determine the amount of time required for hot water to arrive at the fixture. Ready a stopwatch. At the same time that the stopwatch is activated, turn the hot water of the fixture completely on. Allow the water to run until water hot enough to shower in arrives at the fixture, at which point the stopwatch should be stopped. This can be done either manually by placing a hand under the running water or using a digital or infrared thermometer until a temperature of 105°F (40.6°C) is reached. Record the amount of time required for hot water to arrive and convert to minutes.

E6.2.2.4 Next, determine the fixture flow rate. Prepare to collect water from the fixture using a bucket or flow measuring bag by placing the receptacle directly under the fixture. Turn on the water completely while starting a stopwatch. After a minimum of 10 seconds (or as stated on the flow measurement bag), turn off the water. Determine the amount of water collected and multiply by the appropriate factor to obtain the gallons per minute flow rate. Repeat the test to confirm accuracy.

E6.2.2.5 Based on the recorded time required for hot water to arrive and the fixture flow rate in gallons per minute, determine the structural water waste of the hot water delivery system.

E6.2.3 For hot water delivery systems with recirculation loops the auditor shall determine the time-to-tap and the volume-until-hot for key fixtures in the house.

E6.2.3.1 First, ensure that the recirculation loop is full of hot water.

E6.2.3.2 Next, following the procedures in E6.2.2.3 - E2.2.4, turn on the kitchen faucet to full hot and measure the time and volume of water to reach a temperature of 105°F (40.6°C). Repeat this

procedure for the primary shower and for any other faucets or showers that the occupant is concerned with.

E6.2.3.3 Identify the structural waste for the fixtures that have been measured following the procedure in E6.2.2.5.

E6.2.3.4 Where a hot water recirculation system is present, the auditor shall assess the system configuration and operation to identify conditions that may affect water efficiency, energy use, and hot water delivery performance. The assessment shall include:

- Identification of the recirculation system type (e.g., dedicated return line, or use of the cold water line as the temporary return path to the water heater); and the control mechanism (e.g. uncontrolled, timer based, temperature based, a combination of time and temperature based, or demand (presence sensor or manual/push-button demand-controlled)).
- Identification of the pump location and its power consumption.
- Determination of the recirculation control strategy (continuous, scheduled, demand-initiated, or manually controlled).
- Observation of visible insulation on hot water supply and return piping, where accessible. Determine whether or not this insulation is continuous.
- Where the domestic hot water recirculation system utilizes the cold water distribution line as a return path, the auditor shall identify and document this configuration. The auditor shall note this condition as a potential concern due to possible impacts on occupant comfort, water waste, and water quality, including elevated cold water temperatures at fixtures, increased water use while flushing fixtures to obtain cold water, and increased residence time within the distribution system. The intent of this evaluation is to inform occupants and support recommendations related to water efficiency and system performance.

E6.2.3.5 In buildings where the hot water distribution system includes two or more parallel piped branches serving fixtures, the auditor may evaluate whether observed differences in hot water delivery time, temperature stability, or usage patterns suggest unbalanced flow conditions. This evaluation may include:

- Comparison of hot water wait times at fixtures served by different branches.

- Identification of branch configurations that result in disproportionate pipe volume or residence time.
- Identification of observable balancing mechanisms (e.g., balancing valves), where accessible.

Note: The intent of this assessment is to identify distribution characteristics that may contribute to unnecessary water waste, prolonged hot water delivery times, or uneven system performance. This section does not establish plumbing balancing requirements or mandate corrective action. Where imbalances are suspected, the auditor may document findings and consider recommendations such as further evaluation by a licensed plumbing professional.

E6.2.3.6 Optional analysis: If the dwelling is scheduled for a major remodel, an addition, or the piping is being replaced, the auditor can utilize the Water Demand Calculator[27] to assess the benefits of right-sizing the water supply piping from the meter to the branches that serve two or more fixtures or appliances. The intent of this comparison is to identify whether an oversized water delivery system may be contributing to excessive stored volume, increased water waste while waiting for hot water, extended water residence time in piping, or degraded system performance. Where significant differences in calculated pipe sizing are identified, the auditor may note the potential implications for hot water delivery efficiency and consider recommendations consistent with the scope of this annex.

E6.3 Fixtures and Appliances

E6.3.1 The auditor shall conduct an evaluation of indoor, water-using fixtures and appliances, as follows, to identify leaks, maintenance issues, water consumption, and opportunities to improve water efficiency.

E6.3.2 Where components are inaccessible or cannot be evaluated without disassembly, the auditor shall document the limitation and may rely on available information, occupant interviews, or alternative observations.

Note: For all fixtures and appliances, the auditor shall note any supply lines of materials such as rubber, PVC, plastic, or other materials prone to leaks and failures and recommend these be replaced with braided stainless steel lines, with the exception of hot water heater connection lines. Corrugated stainless steel flexible connectors are recommended for connections to a water heater.

E6.3.3 Toilets

E6.3.3.1 The auditor shall assess all toilets installed throughout the building for the following:

E6.3.3.1.1 Toilet Leaks

E6.3.3.1.1.1 Check the angle valve, connections, and base of the toilet for visible leaks,

E6.3.3.1.1.2 Remove the tank lid and visually inspect to ensure that water is not flowing into the tank overflow tube. If water is entering the overflow tube, adjust the water level to be below the overflow tube or recommend replacement of the fill valve. Manually flush the toilet to ensure the flapper sits appropriately and to note if the refill level is too high where water seeps into the overflow.

E6.3.3.1.1.3 Conduct a dye test within the toilet tank to monitor for a flapper leak. Place a dye tablet or ten drops of blue or red food dye into the water within the toilet tank, mixing to ensure color is distributed throughout the tank. Wait for five minutes. After five minutes, check the toilet bowl for dye color. If dye color is within the toilet bowl water, then the flapper is leaking and needs to be replaced. Flush the toilet upon completion of the dye test to avoid staining the tank or bowl.

Note: If the toilet tank is in-wall or otherwise inaccessible, the auditor can consider an alternative leak detection method as follows. The auditor shall ensure that the toilet has not been flushed for at least an hour to ensure the surface of the bowl above the water line is dry. Apply a dark-colored crystal drink mix or food dye around the interior of the toilet bowl, above the water line. Wait five minutes. If the crystals or food dye begin to streak or wash down the bowl, it may indicate a leak from the tank.

E6.3.3.1.2 Toilet Water Consumption

E6.3.3.1.2.1 Inspect the toilet for visible flush volume markings. Flush volume markings are provided in gallons per flush (gpf) and/or liters per flush (Lpf) and are typically located inside the tank or at the back of the bowl.

Note: If the toilet is not marked with the flush volume but does have a manufacture date marking, the auditor can assume the flush volume based on the date. Toilets manufactured before 1994 typically have a flush volume of 3.5 gpf or more. Toilets manufactured after 1994 typically have a flush volume of 1.6 gpf.

E6.3.3.1.2.2 If flush volume markings are not present, the toilet flush volume shall be estimated. To estimate the flush volume, use one of the following options:

- In inches, measure the length of the toilet tank by the width of the toilet tank by the depth of the water in the tank. Multiply length by width by depth to get the tank volume in cubic inches. Divide this number by 231 to estimate water volume in gallons.
- First turn off the water to the toilet using the angle valve. Using a pencil or dry-erase marker, mark the current water level within both the tank and the bowl. Flush the toilet. Next, refill the tank and bowl using a container with volumetric markings or a gallon bucket up to the water level markings, establishing how much water is needed to refill both the tank and bowl. Turn the water supply back on following the test.

E6.3.3.2 Toilet Recommendations

E6.3.3.2.1 Where the toilet flush volume exceeds 1.6 gpf, the auditor shall recommend replacement. When the toilet flush volume is 1.6 gpf, the auditor should consider recommending replacement with a WaterSense®-certified model (1.28 gpf or less) based on household occupancy, water use patterns, and cost effectiveness.

E6.3.4 Showers and Bathtubs

E6.3.4.1 The auditor shall assess all showerheads and shower compartments installed throughout the building for the following:

E6.3.4.1.1 Shower and Bathtub Faucet Leaks

E6.3.4.1.1.1 When the shower is turned off, check the showerhead and tub faucet for visible leaks (e.g., from the showerhead faceplate, tub faucet, or at connection points).

E6.3.4.1.1.2 When the shower is turned on, check for visible leaks at the shower arm, at connection points (e.g., hose for handheld shower), and from the tub faucet, as applicable. If a tub faucet leak appears significant compared to the flow from the showerhead, conduct a tub faucet flow rate measurement by placing a bucket or flow-measuring bag and recording the volume after 10 seconds. Multiply by six to obtain the gallons per minute

leak rate.

E6.3.4.1.2 Shower Head Water Consumption

E6.3.4.1.2.1 Inspect the showerhead for visible flow rate markings. Flow rates are provided in gallons per minute (gpm) and/or liters per minute (Lpm) and are typically located on the faceplate, near the threaded connection point to the shower arm, or elsewhere on the body of the showerhead. A step ladder may be required to view the showerhead markings.

E6.3.4.1.2.2 Estimate the static pressure at the showerhead. Start with the service pressure measured in Section E5.4.1. Adjust this starting pressure by either:

- Subtracting 0.43 psi per foot of elevation if the showerhead is above the location where the service pressure was measured.
- Adding 0.43 psi per foot of elevation if the showerhead is below the location where the service pressure was measured.

If the estimated static pressure at the showerhead is less than 60 psi, remove the showerhead. Inspect the base of the showerhead to determine if the flow regulator in the base of the showerhead a fixed-or pressure compensating orifice. Remove any debris that is clogging the screen.

E6.3.4.1.2.3 Prepare to collect water from the showerhead using a bucket or flow-measuring bag by placing the receptacle directly under the showerhead. Turn on the water completely while starting a stopwatch. After a minimum of 10 seconds (or as stated on the flow measurement bag), turn off the water. Determine the amount of water collected and multiply by the appropriate factor to obtain the gallons per minute flow rate.

Note: Where the flow regulator is a fixed orifice, the pressure will drop proportional to ½ times the square root of 2. Since showerhead flow rates are determined at 80 psi, if the pressure at the showerhead is 40 psi, the flow rate will only be about 70 percent of what it says on the nameplate. If the pressure is 20 psi, the flow rate will only be about 50 percent of what it says on the nameplate.

E6.3.4.1.2.4 If the shower compartment contains multiple showerheads or a showerhead in combination with one or more body sprays, determine through occupant interviews how the shower is typically used for

bathing or combine the flow rates from all sprays that can be used by occupants at one time.

E6.3.4.1.3 Shower Health and Safety

E6.3.4.1.3.1 Evaluate the maximum shower outlet temperature to ensure the temperature is maintained at a safe level to reduce the risk of scalding. Turn on the hot water within the shower for a few minutes to clear cold water from the pipes. Once the shower water has reached its maximum temperature, collect water in a cup or bucket. Use an infrared thermometer or dip a traditional thermometer into the water, allowing the temperature to stabilize. Document temperature reading.

E6.3.4.1.3.2 Through occupant interviews, ask whether shower users experience any sudden water temperature changes.

E6.3.4.2 Showerhead Recommendations

E6.3.4.2.1 Where the showerhead flow rate is greater than 2.0 gpm, the auditor shall recommend replacement. When showerhead replacement is recommended, replace with a high-efficiency model that meets or exceeds WaterSense® criteria (2.0 gpm maximum) or local jurisdiction requirements.

E6.3.4.2.2 Recommendation: When replacing showerheads, specify flow regulators with high-performance pressure compensating orifices to provide a more consistent flow rate over a wide range of actual operating pressures. (See more on pressure-compensating orifices in Section G6.3.5.6).

E6.3.4.2.3 Where the maximum shower outlet temperature exceeds 120°F (49°C), recommend installing or adjusting a thermostatic mixing valve to reduce scalding risk.

E6.3.5 Faucets

E6.3.5.1 The auditor shall assess all faucets installed throughout the building, including kitchen faucets, lavatory faucets (e.g., in bathrooms), and other faucets (e.g., in laundry area, garage) for the following:

E6.3.5.1.1 Faucet Leaks

E6.3.5.1.1.1 When the faucet is turned off, check the faucet for visible leaks from the outlet or at connection

points (e.g., hot and cold connection hoses under the sink).

E6.3.5.1.2 Faucet Water Consumption

E6.3.5.1.2.1 Inspect the faucet for visible flow rate markings. Flow rates are provided in gpm and/or Lpm and are typically located on the body of the faucet or etched into the faucet aerators.

E6.3.5.1.2.2 Prepare to collect water from the faucet using a bucket or flow measuring bag by placing the receptacle directly under the faucet. Turn on the water completely while starting a stopwatch. After a minimum of 10 seconds (or as stated on the flow measurement bag), turn off the water. Determine the amount of water collected and multiply by the appropriate factor to obtain the gallons per minute flow rate. If the calculated flow rate is below 1.0 gpm, above 3.0 gpm, or differs by more than 20% from the marked flow rate, repeat the test to confirm accuracy.

E6.3.5.1.3 Faucet Health and Safety

E6.3.5.1.3.1 Evaluate the maximum faucet outlet temperature to ensure the temperature is maintained at a safe level to reduce the risk of scalding. Turn on the hot water for a few minutes to clear cold water from the pipes. Once the water has reached its maximum temperature, collect water in a cup or bucket. Use an infrared thermometer or dip a traditional thermometer into the water, allowing the temperature to stabilize. Document temperature reading.

E6.3.5.5 Faucet Recommendations

E6.3.5.5.1 Where the lavatory (bathroom) faucet flow rate exceeds 1.5 gallons per minute, the auditor shall recommend replacement of the faucet or faucet accessory (e.g., aerator). When a lavatory faucet or accessory replacement is recommended, replace it with a high-efficiency model that meets or exceeds WaterSense® criteria or local jurisdiction requirements.

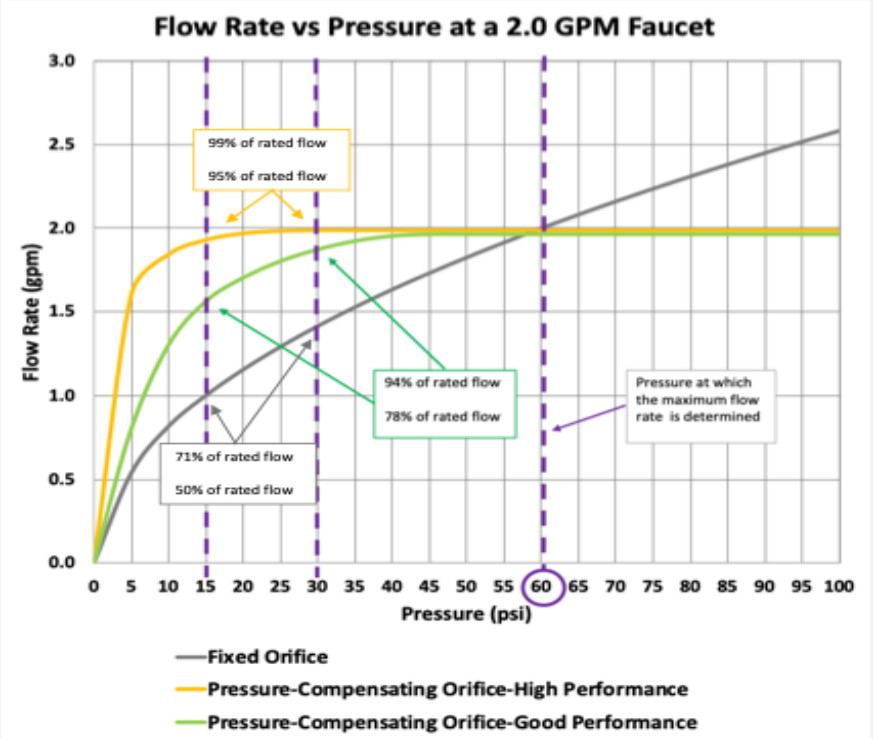
E6.3.5.5.2 Where the kitchen faucet flow rate exceeds 2.2 gallons per minute, the auditor shall recommend replacement of the faucet or faucet accessory (e.g., aerator). When a kitchen faucet or accessory replacement is recommended, replace it with a high-efficiency model with a flow rate of 1.8 gpm or with a flow rate meeting local jurisdiction requirements.

E6.3.5.5.3 Recommendation: When replacing aerators, specify those with high-performance pressure compensating orifices to provide a more consistent flow rate over a wide range of actual operating pressures. (See more on pressure-compensating orifices in Section E6.3.5.6).

E6.3.5.6 Information on Pressure Compensating Orifices

Specifying pressure compensating flow regulators when replacing showerheads and faucets will provide a more consistent flow rate over a wide range of actual operating pressures.

The figure below compares the flow rate versus operating pressure for a 2.0 gpm (7.6 lpm) faucet. The grey curve shows the relationship for a fixed orifice flow regulator. This is a small hole with pressure behind it. The green curve shows the relationship for a good performance pressure compensating flow regulator. The gold curve shows the relationship for a high-performance pressure compensating flow regulator. It is possible to purchase high-performance faucet flow regulators at a wide variety of flow rates and at least three different stream patterns.



E6.3.6 Clothes Washers

E6.3.6.1 The auditor shall assess all clothes washers installed throughout the building for the following:

E6.3.6.1.1 Clothes Washer Leaks

E6.3.6.1.1.1 Check the clothes washer for leaks at all visible connection points, hoses, and valves.

E6.3.6.1.2 Clothes Washer Water Consumption

E6.3.6.1.2.1 Inspect the clothes washer for the manufacturer and model number. The model number is typically located on a sticker or metal tag visible under the lid or inside the door frame of a clothes washer. Look for the ENERGY STAR® label on the model tag or elsewhere on the clothes washer.

E6.3.6.1.2.2 Through occupant interviews, determine the approximate number of daily or weekly loads of laundry.

Note: Average daily clothes washer use in the United States is 0.3 loads per person per day. Using the washer's model number, search online and review manufacturer literature to determine information about the washer, including the washer's drum capacity, gallons per cycle, and/or integrated water factor (gal/cu ft/cycle), and whether it is ENERGY STAR® certified or Consortium for Energy Efficiency (CEE) qualified.

Note: If manufacturer literature is not easily identified, the capacity and water consumption information may be available in one of the following:

- U.S. Department of Energy (DOE) Compliance Certification Database[28]
- ENERGY STAR® product finder[29]
- California Energy Commission (CEC) Modernized Appliance Efficiency Database[30]
- Consortium for Energy Efficiency (CEE) qualified product listing[31]

E6.3.6.4 Clothes Washer Recommendations

E6.3.6.4.1 When clothes washer replacement is recommended, replace with a high-efficiency model that meets or exceeds ENERGY STAR® or CEE criteria or local jurisdiction requirements.

Note: Front-loading washers are generally more water-efficient than top-loading washers.

E6.3.7 Dishwashers

E6.3.7.1 The auditor shall assess all dishwashers installed throughout the building for the following:

E6.3.7.1.1 Dishwasher Leaks

E6.3.7.1.1.1 Check the dishwasher for leaks at all visible connection points, hoses, and valves.

E6.3.7.1.2 Dishwasher Water Consumption

E6.3.7.1.2.1 Inspect the dishwasher for the manufacturer and model number. The model number is typically located on a sticker or metal tag visible on the top or side of the door or inner frame of the dishwasher. Look for the ENERGY STAR® label on the model tag or elsewhere on the dishwasher.

Note: Average daily dishwasher use in the United States is 0.1 loads per person per day.

E6.3.7.1.2.2 Using the dishwasher's model number, search online and review manufacturer literature to determine information about the dishwasher, including the dishwasher's gallons per cycle and whether it is ENERGY STAR® certified or Consortium for Energy Efficiency (CEE) qualified.

Note: If manufacturer literature is not easily identified, the capacity and water consumption information may be available in one of the following:

- U.S. Department of Energy (DOE) Compliance Certification Database[32]
- ENERGY STAR® product finder[33]
- California Energy Commission (CEC) Modernized Appliance Efficiency Database[34]
- Consortium for Energy Efficiency (CEE) qualified product listing[35]

E6.3.7.2 Dishwasher Recommendations

E6.3.7.2.1 When dishwasher replacement is recommended, replace with a high-efficiency model that meets or exceeds ENERGY STAR® or CEE criteria or local jurisdiction requirements.

E6.3.7.2.2 The auditor shall communicate that dishwasher use is typically more water-efficient than handwashing dishes.

E6.3.8 Water Softeners

E6.3.8.1 The auditor shall assess all water softeners installed throughout the building for the following:

E6.3.8.1.1 Water Softener Leaks and Maintenance Issues

E6.3.8.1.1.1 Check the water softener for leaks at all visible connection points, hoses, valves, and drains. A continuous trickle or flow of water in the drain line is indicative of a broken valve.

E6.3.8.1.1.2 Inspect the water softener brine tank for indications of maintenance issues. A properly functioning softener should have salt above the water line, have no salt bridges (i.e., salt crust without a bed of salt pellets beneath), and have no salt sludge at the base of the brine tank.

E6.3.8.1.2 Water Softener Water Consumption

E6.3.8.1.2.1 Using the softener's model number, search online and review manufacturer literature to determine information about the softener, including regeneration control (e.g., demand-initiated, timer-based, or manual), the softener's rated softening grain capacity, water used per regeneration, and/or total water consumption per 1,000 grains.

E6.3.8.1.2.2 For softeners with timer-based regeneration control, review the water softener control panel to determine regeneration frequency.

Note: Ideal regeneration frequency is determined based on incoming water hardness, household occupancy, typical water consumption, and softener capacity. Too frequent regeneration causes excessive salt and water consumption. Too infrequent regeneration may not be providing the desired level of softening.

E6.3.8.2 Water Softener Recommendations

E6.3.8.2.1 Where an occupant is not aware that a water softener is installed or is otherwise not maintaining the water softener (e.g., not refilling the brine tank with salt) such that it

is not producing softened water, recommend that the water softener be bypassed and the softener be unplugged to prevent regeneration.

E6.3.8.2.2 The auditor shall recommend water softener replacement when:

- The system uses timer-based regeneration (not demand-initiated) and water consumption exceeds 4.0 gallons per 1,000 grains removed,
- Or maintenance issues identified in E6.3.8.2 cannot be cost-effectively resolved.

E6.3.8.2.3 When water softener replacement is recommended, replace with a softener that uses demand-initiated regeneration (DIR) and meets the NSF/ANSI 44 Residential Cation Exchange Water Softeners[36] standard voluntary efficiency rating of 4.0 gallons of water or less per 1,000 grains of hardness removed. Recommended water softener size (i.e., grain capacity) should take into consideration local water hardness and actual or anticipated household water consumption based on assessment findings.

E6.3.8.2.4 Investigate local incentives for water softener removal and recommend as applicable.

E6.3.9 Reverse Osmosis (RO) Systems

E6.3.9.1 The auditor shall assess all RO systems installed throughout the building for the following:

E6.3.9.1.1 RO System Leaks

E6.3.9.1.1.1 Check the RO system for leaks at all visible connection points, hoses, and valves.

E6.3.9.1.1.2 Inspect the RO system drain line for active discharge of water. A continuous flow of water to the drain can be indicative of a faulty auto-shutoff valve that requires replacement.

E6.3.9.1.2 RO System Water Consumption

E6.3.9.1.2.1 Inspect the RO system for the manufacturer and model number. The model number is typically located on a data plate affixed to the RO system's storage tank or filter housing.

E6.3.9.1.2.2 Using the RO system's model number, search online and review the model's performance data sheet to determine the RO system's efficiency rating.

Note: An RO system efficiency rating is determined by the percentage of water going into the system that becomes available to the user as treated water under typical operating conditions. A higher efficiency rating indicates a more water-efficient system.

E6.3.9.2 RO System Water Consumption

E6.3.9.2.1 RO systems with efficiency ratings below 30 percent should be considered for replacement. Systems with ratings below 20 percent should be prioritized for replacement or alternative filtration methods.

E6.3.9.2.2 When RO system replacement is recommended, consider recommending an alternative water filtration system that does not have a wastewater stream but can meet household water treatment goals. If an RO system is still desired, recommend a high-efficiency model that meets or exceeds WaterSense® criteria, is certified to ASSE 1086,[37] or otherwise has an efficiency rating greater than 30 percent.

E6.3.9.2.3 The auditor shall communicate that RO water should only be used for drinking and cooking. Water treated to RO system quality is not necessary for other household uses (e.g., toilet flushing, clothes washing, bathing). Whole-house or point-of-entry systems should be discouraged.

E6.3.10 Evaporative ("Swamp") Coolers

E6.3.10.1 Where swamp coolers are installed on ground level or accessible without roof access, the auditor shall assess all evaporative coolers installed throughout the building for the following:

E6.3.10.1.1 Evaporative Cooler Leaks and Maintenance Issues

E6.3.10.1.1.1 Check the evaporative cooler for leaks at all visible connection points, water lines, and around the water sump, and that no water is flowing into the overflow drain. Adjust the float valve if water is entering the overflow drain. Ensure the float valve in the sump is operating correctly and shuts off make-up water when the sump is full.

E6.3.10.1.1.2 Inspect water sump, pads, and other surfaces for signs of scale build-up, which can cause corrosion and inefficient cooling.

E6.3.10.1.1.3 Inspect the water sump and pads for signs of mold or algae growth.

E6.3.10.1.1.4 If the evaporative cooler is operating, inspect to ensure hoses are positioned correctly over pads and provide even distribution of water. Be sure water distribution holes are not clogged.

E6.3.10.1.1.5 Based on occupant interviews, determine the frequency of maintenance to remove scale, replace cooling pads, and ensure efficient operation.

Note: Evaporative coolers should be maintained at a minimum once a year before the cooling season (pad replacement, scale removal, system cleaning). In residences with hard water, mid-season maintenance may be necessary.

E6.3.10.1.2 Evaporative Cooler Water Consumption

E6.3.10.1.2.1 Open the side of the evaporative cooler and check to ensure the float valve works properly.

E6.3.10.1.2.2 In areas of freezing climate, ensure there is a water shut-off valve easily accessible, preferably not requiring roof access.

E6.3.10.2 Evaporative Cooler Recommendations

E6.3.10.2.1 If scale deposits exceed ¼ inch (0.64 cm) thickness on pads or sump surfaces, or if corrosion has compromised metal components, recommend maintenance or servicing by a professional HVAC vendor to remove scale build-up.

E6.3.10.2.2 If evaporative coolers do not have a sump to catch and recirculate water, recommend replacement with a cooler capable of recirculating water.

E6.3.11 Other Water-Using Fixtures and Appliances

E6.3.11.1 The auditor shall inspect all other water-using fixtures, appliances, or systems that are installed inside the home for leaks at all visible connection points, hoses, valves, and drains. Additional indoor water-using equipment can include, but is not limited to:

- Bidets
- Urinals
- Refrigerators (with integrated water filter and/or ice maker)
- Ice machines
- Humidifiers
- Hot tubs
- Other water treatment systems
- Other hard-plumbed features or appliances (e.g., fish tanks, fountains, coffee machines)

E7. Outdoor Water Assessments

E7.1 Outdoor Water Distribution Systems

G7.1.1 Outdoor Irrigation

E7.1.1.1 The auditor shall assess all aspects of the irrigation system for the following. The outdoor irrigation audit assumes a functional and operational irrigation system. If the system is not functional, the auditor shall consider recommending a certified or licensed irrigation professional to restore it to a functional state.

E7.1.1.1.1 To assist with an organized, structured auditing process, Irrigation Association Landscape Audit Worksheets[38] may be used.

E7.1.1.2 Irrigation Metering and Flow Monitoring Recommendations

E7.1.1.2.1 Where the irrigation system does not have a dedicated irrigation meter, the auditor shall recommend a irrigation submeter or flow monitoring device be installed on the system to support irrigation water management.

E7.1.2 Backflow Preventors

E7.1.2.1 The auditor shall assess all backflow prevention devices installed throughout the irrigation system for the following. The intent is to determine the presence and type of backflow prevention device installed and identify leaks or maintenance issues.

E7.1.2.1.1 Determine the local code pertaining to approved irrigation backflow devices.

E7.1.2.1.2 Locate the irrigation backflow prevention device on the property.

E7.1.2.1.3 Note the type, brand, and model of the backflow prevent device. Note if the device is insulated or not.

E7.1.2.1.4 Note the physical condition, location, and check for leaks.

E7.1.2.2 Backflow Prevention Device Recommendations

E7.1.2.2.1 If there is no backflow prevention device present, or if an incorrect model is installed, then recommend replacing the backflow prevention device with an appropriate model that meets local code.

E7.1.3 Site Mapping

E7.1.3.1 The auditor shall assess the location of all components of the irrigation system and perform the following:

E7.1.3.1.1 Mapping of significant components and findings should be completed during the assessment on a current site map. Mapping should include the locations of meters, zones, sprinkler heads, issues found, valve boxes, controllers, and backflow devices, as applicable.

E7.1.4 Irrigation Controllers

E7.1.4.1 The auditor shall assess all irrigation controllers installed at the building for the following. The intent is to determine the type of controller installed and its operating parameters.

Note: If the controller has device sharing type capability, it is recommended to get access to this capability.

E7.1.4.1.1 Determine if the local jurisdiction has time-of-day or day-of-the-week watering restrictions.

E7.1.4.1.2 Locate and note the irrigation controller(s) on the property. If multiple, repeat each of the steps below for each controller.

E7.1.4.1.3 Determine and note the make and model number of the controller, and if the controller is EPA

WaterSense® labeled or has accessories to make it WaterSense® equivalent.

E7.1.4.1.4 Note: If the WaterSense® label is not displayed on the controller, the auditor can determine whether the controller is WaterSense® labeled by using the WaterSense® Product Search Tool.[39]

E7.1.4.1.5 Determine and note if the controller has any optional flow measuring and monitoring equipment attached to it. If so, note the type, brand, and model.

E7.1.3.1.6 Determine and note if there is a battery backup installed in the controller and check for low-battery indicators. Close the valve wire cover.

E7.1.4.1.7 Determine if the controller has a time and day displayed, and note if the time and day displayed are accurate.

E7.1.4.1.8 Open the controller covering the valve wiring. Determine and note if there are any loose connections or broken wires.

E7.1.4.1.9 Determine and note the schedule for each zone. Note the length of the schedule for the zone in minutes, number of cycles per day, frequency/interval, and duration of irrigation, days of the week that watering occurs, and seasonal adjust/budget.

E7.1.4.1.10 Determine local monthly evapotranspiration rate and rainfall data for the site.

Note: This information is usually available from the local water conservation or agricultural office. Additionally, this information is also available from the EPA or organizations like OpenET (www.openetdata.org).

E7.1.4.1.11 Determine the landscape irrigation water budget for the site.

Note: This information is used in the calculating the water budget for the landscape. This formula is generally:

Annual Landscape Water Budget = Landscaped Area x Annual evapotranspiration rate x .623

Note: Some jurisdictions, like California, have a specific irrigation of water budget formulas and these should be used. The EPA publishes a tool to assist in determining water budget for a site:

https://www.epa.gov/watersense/water-budget-tool.

E7.1.4.2 Irrigation Controller Recommendations

E7.1.4.2.1 Where irrigation controllers are not WaterSense® labeled or do not rely on local weather or soil-moisture conditions, consider recommending replacement. If controller replacement is recommended, replace with WaterSense® labeled controller.

E7.1.4.2.2 If the controller settings are outside local jurisdictional water requirements, note to the homeowner that the settings should be adjusted to conform to local requirements.

E7.1.4.2.3 If the actual landscape water usage is greater than 25% above the Annual Water Budget, the auditor shall recommend a full irrigation water audit.

E7.1.5 Zone Information

E7.1.5.1 The intent below is to determine information on each irrigation zone.

E7.1.5.1.1 Note the slope of each irrigation zone.

E7.1.5.1.2 Note the microclimate of each irrigation zone.

E7.1.5.1.3 For each of the zones, determine and note the type of irrigation method. If spray irrigation is used, note if different types of spray irrigation are used.

E7.1.5.2 Zone Recommendations

E7.1.5.2.1 If the irrigation zone has a mix of micro and spray irrigation, recommend that the zones be split so that micro and spray are separate irrigation zones with separate schedules.

E7.1.5.2.2 If the zone has spray heads, consider recommending replacement with rotary/multi-spray, multi-trajectory (MSMT) type irrigation heads.

E7.1.6 Pressure Test

E7.1.6.1 The auditor shall assess the pressure of the irrigation system for both the static and dynamic pressure of the irrigation system.

E7.1.6.1.1 Connect a pressure gauge to an outdoor hose bib or other fixture and note the pressure in pounds per square inch (PSI) with nothing operating.

E7.1.6.1.2 Connect a pressure gauge to the irrigation system by connecting to the filter body, a spray head connection (after removing the spray head), or at the drain valve in the irrigation valve box.Turn on the irrigation system and note the dynamic pressure.

E7.1.6.2 Irrigation system pressure recommendations

E7.1.6.2.1 If static PSI exceeds 75 PSI, consider recommending that a Pressure Reducing/Regulating Valve (PRV) be installed.

E7.1.7 Master (Primary) Irrigation Shut-Off and Other Valve Boxes

E7.1.7.1 The auditor shall assess all master (primary) irrigation shut-off valves and other valve boxes throughout the irrigation system for the following:

E7.1.7.1.1 Locate the master irrigation shut-off/isolation valve and other irrigation valve boxes on the property and check each for leaks. If multiple, repeat each of the steps below for each controller.

E7.1.7.1.2 Open each valve box, note for loose wires, broken connections, or visible water leakage. Note if the valve boxes cannot be located and were not assessed.

E7.1.7.1.3 Note the number of valves in each box, along with the condition and if any filters or pressure-reducing valves are co-located with the master valve(s).

E7.1.7.1.4 Using the controller, manually turn on each zone sequentially on the irrigation controller and check the appropriate valve box for leaks. Repeat for each valve in all valve boxes. Note if any of the valves are leaking or appear to be faulty.

E7.1.7.1.5 Determine if there are any stub-outs or stub-ins that are not in use.

Note: If there are electrical issues, consider using DBY connectors.

E7.1.7.2 Master (primary) Irrigation Shut-off Valve Recommendations

E7.1.7.2.1 If there is no master irrigation shut-off valve on the system, the auditor shall recommend one be installed to allow system maintenance, winterization, and/or repair.

E7.1.8 Irrigation Sprinkler Heads and Nozzles

E7.1.8.1 The auditor shall assess all irrigation sprinkler heads and nozzles installed throughout the irrigation system for the following. The intent is to determine if the sprinkler heads and nozzles are operating properly.

E7.1.8.1.1 Turn on the zone and observe for visible leaks in the valve, spray heads, or piping.

E7.1.8.1.2 Note if there are any leaks or runoff. To determine runoff, the auditor shall isolate and run zones that may be prone to runoff (i.e., next to the curb or sidewalk) and let run for the existing zone time on the controller to determine if any runoff is occurring around the sides of the irrigated site.

E7.1.8.1.3 With the spray on, observe the spray of the head to determine if the head is broken, over-spraying, or under-spraying the intended irrigation area. Note heads that are not performing correctly. Note if the heads have a pressure regulator and/or check valves.

Note: It is recommended to include spray heads with unique identifying numbers on the site map. Note by zone/valve location if there are any issues.

E7.1.8.2 Irrigation sprinkler head and nozzles recommendations

E7.1.8.2.1 If there is run off occurring during the test of the zone, the auditor shall recommend adjusting the controller to include multiple start times or utilize a cycle and soak feature if available to reduce or eliminate runoff.

E7.1.8.2.2 Heads at the bottom of all sloped areas should be heads with integrated check valves.

E7.1.8.2.3. Note if turf and non-turf are irrigated on the same zone. If so, recommend these areas be separated into zones with unique irrigation scheduling.

E7.1.9 Micro-Irrigation

E7.1.9.1 The auditor shall assess micro irrigation (e.g., drip irrigation, microspray irrigation) lines installed throughout the irrigation system for the following. The intent below is to determine if the micro-irrigation emission devices are operating properly.

E7.1.9.1.1 Check the micro-irrigation system for leaks and note the location on the site map. Note where there is irrigation and no plants.

E7.1.9.1.2 In the irrigation valve box, determine and note if there are filters or pressure-reducing valves for the micro-irrigation zone valves. For the pressure-reducing valve, note its marked pressure. If there is no pressure-reducing valve or filter, these should be recommended.

E7.1.9.1.3 Turn on the zone and assess the micro irrigation line for visible and auditory leaks in the piping, missing or broken drip heads, or drip heads without any nearby plants. Note if there are any leaks or problems with the drip heads. Note the location of any adjustable heads.

E7.1.9.1.4 With the micro-irrigation on, determine and note the square foot area of the intended irrigation area. Record the distance between rows and the distance between emitters. It is recommended to flag the irrigation area, shut off the irrigation, and measure the square footage of the area. Leave the flags in place until the planting type is determined. On the site map of the micro-irrigated area, the numbers indicate the beginning, middle, and end of the drip zone.

E7.1.9.1.5 Determine and flag the end of the micro-irrigation zone.

E7.1.9.1.6 Determine and flag the approximate middle of the micro-irrigation zone.

E7.1.9.1.7 Take a pressure test at the middle and end of the micro-irrigation line. Note the readings. If the pressure drop exceeds 20% from the beginning to the mid-point or from the mid-point to the end of the line, a blocked or cut micro irrigation line is likely to be the cause.

E7.1.9.1.8 Inspect a selection of the drip heads in the line to make sure water is visible. Note any heads that are not working properly. The auditor shall inspect about 5-10% of the drip heads on the line.

E7.1.9.1.9 Determine if there is a temporary irrigation (e.g., irrigation connected to a hose bib) and evaluate if present. Irrigation connected to a hose bib requires an atmospheric vacuum breaker.

E7.1.9.2 Micro-irrigation recommendations

E7.1.9.2.1 If there is no pressure reducing valve or filter, these should be recommended. Recommendation: If the reading is greater than 20-30% less from the beginning to the mid-point or from the mid-point to the end of the line, a blocked or cut micro irrigation line is likely to be the cause. Recommend the complete line be inspected, repaired, or replaced by a certified or licensed irrigation specialist.

E7.1.10 Application Rates

E7.1.10.1 The auditor shall assess for Smart or Weather-Based Irrigation Controllers (WBIC), that each irrigation valve/zone is correctly programmed with the appropriate sprinkler nozzle type or drip application type. Based on audit findings, the auditor shall recommend programming corrections if required.

E7.1.10.1.1 For each zone and compare the programmed value to the effective, delivered, or actual precipitation rate for the zone using an appropriate determination methodology. Where discrepancies are identified, the auditor may recommend adjustments to the programmed precipitation rate consistent with the audit findings.

Note: Smart/Weather-Based Irrigation controllers are pre-programmed with application rates. These application rates tend to be too high and overwater the landscape.

E7.1.10.1.2 Typical manufacturer default precipitation rates used by Smart/WBICs controllers include:

- Pop-Up Spray: 1.5 - 2.0 inches per hour (in/hr)
- Rotors: 0.4 - 0.6 in/hr
- Multi-Stream/MP Rotators: ~0.4 in/hr
- Drip/Micro-Irrigation: 0.1 - 0.2 in/hr

E7.1.10.1.3 Determine the effective, delivered, or actual precipitation rate for the irrigation zone using one of the below methods. The auditor shall select the most appropriate method based on site conditions, data availability, and audit objectives.

E7.1.10.1.3.1 Field test method: Perform a Catch-Can Test on the zone to determine the area application rate based on the test and calculate the precipitation rate for the zone based on the irrigation run time on the controller.

E7.1.10.1.3.2 Hydraulic method: Calculate the precipitation rate based on a meter flow rate for the zone based on the irrigation run time on the controller.

E7.1.10.1.3.3 Component-based method: Add all the precipitation rate of all irrigation components in the zone based on the irrigation run time on the controller.

E7.1.10.1.3.4 Specification-based method: Using manufacturer documentation and a listing of all the irrigation components in the zone, add up the application rate for the zone, based on the irrigation run time on the controller.

Note: When recommending an adjustment to the programmed precipitation rate, it is recommended that the auditor apply an Efficiency / Distribution Uniformity (DU) factor of no less than 70 percent ($\eta = 0.70$) for spray and rotor and 85 percent ($n = 0.85$) for drip irrigation unless field-measured data supports a higher value. Conducting a catch-can test may allow the auditor to determine the actual distribution uniformity for the irrigation zone.

E7.1.10.1.4 Calculate the correct application rate.

E7.1.10.1.4.1 Note the programmed application rate on the controller.

E7.1.10.1.4.2 Note the application rate based on the method from H7.1.10.1.3.

E7.1.10.1.4.3 Using the application rate from above, multiply this rate by the correct Efficiency/Distribution Uniformity co-efficient

E7.1.10.1.4.4 Example Calculation:

- The auditor observes that Zone 1 on a Smart/WBIC is programmed as Pop-Up Spray with a precipitation rate of 1.5 in/hr.
- Using the hydraulic (flow rate + area) method, the auditor determines that Zone 1 has an effective precipitation rate of 3.2 in/hr.

- To determine a recommended programmed precipitation rate, the auditor applies a 70% efficiency factor:
  - 3.2 in / hour x 0.70 = 2.24 inches/hour

E7.1.10.2 Application Rates Recommendations

E7.1.10.2.1 Compare the calculated precipitation rate to the rate included in the Smart/Weather based controller. If the amount is off by more than 10%, the auditor shall recommend adjusting the values programmed into the controller.

E7.1.11 Soil Type

E7.1.11.1 The auditor shall assess soil throughout the irrigation area for the following:

E7.1.11.1.1 Determine local jurisdiction watering best practices by soil type based on the climatic region and share with occupants, as applicable.

E7.1.11.2 Soil Type Recommendations:

E7 1.11.2.1 For landscape and tree beds, note the depth and type of mulch covering. If less than 2 inches (5.1 cm) of mulch, recommend that more mulch be added to get to a mulch depth of 2 to 4 inches (5.1 to 10.2 cm).

E7.1.12 Optional: Planting Types

E7.1.12.1 The auditor shall assess all the plantings throughout the irrigation system for the following:

E7.1.12.1.1 Determine if there are any areas planted with non-native turf grass.

E7.1.12.1.2 Determine if there are any restrictions or limits on planting areas for specific types of plants for the local jurisdiction (e.g. turf or other plantings are restricted to a certain percentage of total area).

E7.1.12.2 Planting Type Recommendations

E7.1.12.2.1 The auditor shall recommend replacing non-native turf grass with lower water-use plants. If the local jurisdiction has a suggested plant listing, provide it to the homeowner

E7.1.12.2.2 If there are any exceedances of local jurisdictional limits or restricted plant types present, provide the listing or webpage of the prohibited plants and plant restrictions to the homeowner and recommend changing to meet the local requirements. If the local jurisdiction has a publication on noxious weeds and invasive species, provide that information to the homeowner.

E7.1.13 Water Reuse

E7.1.13.1 The intent of this section is to determine if there is any alternative reuse in use on the site and/or determine if there is any potential for water reuse on the site. While the residential water reuse industry has not standardized, the auditor may recommend to the homeowner options for reusing water, depending on identified opportunities. Reuse includes greywater, rainwater, blackwater, stormwater retention basins, and condensate capture and reuse.

E7.1.13.1.1 Determine and note if there is any water reuse on the property. Determine and note the source of water reuse and the end use of captured water.

E7.1.13.1.2 Inspect onsite water reuse system for visible leaks.

E7.1.13.1.3 Determine and note if there are any potable water connections to the water reuse connection and if so the type of backflow device installed at the connection.

E7.1.13.2 Water Reuse Recommendations

E7.1.13.2.1 Recommend the homeowner repair any identified leaks in the reuse system.

E7.1.13.2.2 If there is a potable water cross connection with the reuse system, recommend the homeowner install a backflow preventer to prevent potable water system contamination from the reuse system.

E7.2 Outdoor Water Features

E7.2.1 Outdoor Water Features Assessment

The auditor shall assess all aspects of the swimming pools, spas and ponds (i.e., water feature) for the below.[20]

E7.2.1.1 Note the square footage of the all water feature surface areas. Document area and note any methods employed to reduce evaporation; these could include chemicals, physical covers, tree coverings, or wind break walls.

E7.2.1.2 Inspect all the water feature fittings for leakage when the pool pump is operating.

E7.2.1.3 Perform a leak test of the water feature over a 24-hour period. A 12- to 24-hour bucket test can be performed to determine if a leak. Make sure any auto-fill is turned off. Fill bucket to same height as water level. Mark the level on the bucket. Place bucket in the water feature so the levels are equal inside and outside. When placing the bucket in the water feature make sure it receives approximately the same amount of solar intensity as the rest of the water feature. Return in 12-24 hours to note if the mark on the bucket is different from the level of the water feature.

E7.2.1.4 Determine the current type of water feature cleaning vacuum.

E7.2.1.5 Determine the frequency of backwashing, how backwashed (i.e. manually or automatic), and where the backwash for the water feature is sent (e.g. sewer, yard, etc.)

E7.2.1.6 Determine if there is a meter installed on the makeup water line.

E7.2.2 Outdoor Water Features Recommendations

E7.2.2.1 If leak detected, recommend these leaks be fixed as soon as possible.

E7.2.2.2 If the backwash is manual, recommend upgrade to controller base backwash to automate the process, save time, reduce water waste.

E7.2.2.3 If vacuum method is determined to be using the existing pool filter, recommend a stand-alone pool cleaning system be employed. These systems do not use the pool filter; thus reducing the need to backwash.

E7.2.2.4 If no evaporative protection for the water feature, recommend some method of reducing evaporation be installed.

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[20] Pools, spas, and potable hot tubs can consume large amounts of water and are covered in Section 12 of BPI-1200.

E7.2.2.5 If there is no meter installed on the makeup water line, recommend a smart water meter be installed.

E8 Water Annex Homeowner/Occupant Questionnaire

E8.1 This questionnaire provides a list of sample questions and information on household water behavior, building water efficiency performance, and possible health and safety issues.

E8.2 Customer/Site Questions:

E8.2.1 General site questions

- What is the address of the site?
- What is the first and last name of the site auditor?
- What is the date of the audit?
- What is the location of the meter(s)? From the customer bill, note the meter size.
- Are there any sub-meters or additional water meters installed?
- Is there a dedicated irrigation meter? (Yes/No)

E8.2.2 General homeowner questions

- Are there any specific concerns or questions you want to address today, including any specific health and safety or comfort issues?
- Have you noticed any changes in your water bills or usage over time?
- Are there time or budget considerations I should keep in mind when discussing your audit findings and recommendations?
- What matters most to you when deciding to make changes in your home's water use? Comfort, cost, convenience, or something else?
- What would make a water saving change feel worthwhile to you?
- Have you tried reducing water use in your home? If so, what worked and what didn't?
- Are there any major renovations, such as additions, remodeling kitchens or bathrooms, finishing of basement or attic, planned in the next 12 months?

E8.2.3 Home water use behavior questions

- What is the typical occupancy of the home?
- Does household occupancy vary seasonally?

- Which bathrooms are most frequently used in the home for showering? For toilet flushes? Are any bathrooms used infrequently or not at all?
- Showers
  - For showers with multiple sprays, what combination of sprays are typically used?
  - Does the occupant experience any sudden fluctuations in water temperature?
- Clothes Washers
  - What are the approximate number of daily or weekly loads of laundry?
- Dishwashers
  - Is the dishwasher used regularly?
  - What are the approximate number of daily or weekly loads of dishes?

E.2.4 Irrigation system questions

- What is the location of the irrigation controller?
- What is the location of the irrigation valve box(es)?
- Are there any pets or children onsite that would prevent entry into the yard?
- What is/are the water source(s) for the house? (Utility, Well, Rainwater)
- What is/are the water source(s) for the irrigation system? (Utility, Well, Rainwater, Graywater, Reclaimed Water/Treated Effluent/Purple Pipe)
- What are the billing units for the meter? (e.g. gallons, CCF)
- Is there an irrigation site drawing or site plan?
- Is the area prone to freezing temperatures?
- Are there areas that are manually watered? If so, which areas, how often, how long?

E8.2.5 Water Reuse System Questions

- Is there any water reuse system(s) onsite? If yes, is that system documentation available?
- Do you have any or are you planning on installing a onsite water reuse system?
- Are you opposed or support evaluating onsite water reuse?
- Are there any local jurisdiction restrictions or rebates for onsite residential water reuse?
- If they have a onsite reuse systems, what is the source of the water and what is the use of the water for each system?
- If they have a onsite reuse system, what is the size of the collection tanks?
- Are there any planned changes in these water reuse systems?

~~Annex A | BPI-1200-S-202x Referenced Documents (Normative)~~

NOTE: This annex has been replaced by a References section in BPI 1200, with references updated and citations included in the standard's text.

~~Item~~	~~Date~~
~~ANSI/ACCA 4-2007: Maintenance of Residential HVAC Systems~~	~~2007~~
~~ANSI/ACCA 5 QI-2010, HVAC Quality Installation Specification~~	~~2010~~
~~ANSI/ACCA 6-2007, Restoring the Cleanliness of HVAC Systems~~	~~2007~~
~~ANSI/Z21.11.2–2011: Gas-Fired Room Heaters - Volume II, Unvented Room Heaters~~	~~2011~~
~~ANSI/BSR Z223.1/NFPA 54: National Fuel Gas Code~~	~~2015~~
~~ANSI/AMCA Standard 210-07 | ANSI/ASHRAE 51-07: Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating~~	~~2007~~
~~ANSI/APSP-14 2011, Standard for Portable Electric Spa Energy Efficiency~~	~~2011~~
~~ANSI/ASTM E-779-10, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization~~	~~2010~~
~~ANSI/BPI-1100-T-2014 Home Energy Auditing Standard~~	~~2014~~
~~ANSI/BPI-2400-S-2012 Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History~~	~~2012~~
~~ASHRAE Standard 62.2 – 2013: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings~~	~~2013~~
~~CAN-CGSB-149.0010-1986, Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method~~	~~1986~~
~~National Oilheat Research Alliance Routine Fuel Oil Storage Tank Evaluation – Above Ground Tanks Checklist~~	~~2006~~
~~NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances~~	~~2013~~
~~RESNET Mortgage Industry National Home Energy Rating Systems Standards, Section 802~~	~~2013~~
~~Procedures for Certifying Residential Energy Efficiency Tax Credits RESNET Publication No 13-001 Jan. 15, 2013~~	~~2013~~
~~U.S. Department of Energy Weatherization Program Notice 01-4 http://www.waptac.org/data/files/technical_tools/wpn01-4.pdf~~	~~2000~~
~~U.S. Department of Energy Weatherization Program Notice 05-5~~	~~2005~~

Documents can be ordered from the following:

ACCA: Air Conditioning Contractors of America
2800 Shirlington Road, Suite 300
Arlington, VA 22206
(703) 575-4477
www.acca.org

ANSI: American National Standards Institute
1899 L Street, NW
11th Floor
Washington, DC, 20036
www.ansi.org

APSP: Association of Pool and Spa Professionals
2111 Eisenhower Ave.,
Alexandria, VA 22314
www.apsp.org

ASHRAE: American Society of Heating Refrigeration and Air-conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, GA 30329
(404) 636-8400
www.ashrae.org

ASTM: ASTM International
100 Barr Harbor Drive, PO Box C700
West Conshohocken, PA, 19428
(877) 909-2786
www.astm.org

BPI: Building Performance Institute, Inc.
107 Hermes Road
Malta, NY 12020
(877) 274-1274
www.bpi.org

CGSB: Canadian General Standards Board
11 Laurier Street
Gatineau, Canada K1A 1G6
(800) 665-2472
www.tpsgc-pwgsc.gc.ca

NFPA: National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471
(617) 770-3000
www.nfpa.org

National Oilheat Research Alliance
600 Cameron Street, Suite 206
Alexandria, VA 22314
(703) 340-1660
www.nora-oilheat.org

RESNET: Residential Energy Services Network, Inc.
P.O. Box 4561
Oceanside, CA 92052-4561
www.resnet.us

U.S. Department of Energy
1000 Independence Ave SW
Washington, DC 20585
(202) 586-5000
www.energy.gov

~~Annex B | BPI-1200-S-2017 Terms and Definitions (Informative)~~

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for the conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

NOTE: This annex has been superseded by the National Laboratories of the Rockies (NLR) Standard Work Specifications: https://sws.nlr.gov/lexicon

~~Term~~	~~Definition~~
~~1.5 Story Home~~	~~A home that meets the classification of 1.5 story for the purposes of this standard would typically be a raised ranch (*ASHRAE 62.2*-2013) specifies only the "above grade portion" of the home) or a tri-level house where the upper story is only offset from the ground floor by a ½ story. (A Cape Cod style home is considered a 2 story home for the purposes of this standard.)~~
~~Authority Having Jurisdiction (AHJ)~~	~~The Authority Having Jurisdiction [AHJ] is the organization, office, or individual with final and ultimate authority for approving equipment, materials, an installation, or a procedure, where jurisdiction includes the governmental or administrative territory within which authority may be exercised, and also the scope of what trades, professions, devices or systems they regulate.~~ ~~Where public safety is the primary concern, the AHJ may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. Within federal, state, local, or other regional programs, the program administrator, utility commission, or others having regulatory authority or responsibility for the program may be the AHJ.~~ ~~In many cases, there may be more than one organization, agency, or department that has "jurisdiction" over particular work, but regulations and statutes establish and define~~

	relationships and levels of authority, so that only one entity has "authority." A good example of this overlap is the one between an energy program funding source and code officials. If the project in question is a solar/PV project operating under program rules but also subject to State electrical codes, the funding source can require construction practices only to the extent that the required work does not violate the applicable electrical code, and so the code inspection office (or official) empowered under the state electrical code is the AHJ. If there is also a county or city electrical inspection office, state law identifies the AHJ, as it defines which entity has the highest level of authority and responsibility.
British Thermal Unit (BTUh) per hour	A unit for measuring energy, equal to the amount of energy needed to increase the temperature of 1 pound of water by 1 degree Fahrenheit. BTUh is a rate of energy delivery, 1 BTU per hour.
Building Science	The study of the interaction between the various building construction materials, products, assemblies and subsystems, and the whole-building system, the occupants of these buildings, and the environments in which they are located, and also the practices or procedures needed to achieve a desired outcome, particularly quality, high performance buildings.
Carbon Monoxide (CO) Air Free	Air free emission levels are based on a mathematical equation (involving carbon monoxide and oxygen or carbon dioxide readings) to convert an actual diluted flue gas carbon monoxide testing sample to an undiluted air free flue gas carbon monoxide level utilized in the appliance certification standards. For natural gas or LP gas, using as-measured CO ppm and O_2 percentage: $CO_{AFppm} = \times CO_{ppm}$ Where: CO_{AFppm} = Carbon monoxide, air-free ppm CO_{ppm} = As-measured combustion gas carbon monoxide ppm O_2 = Percentage of oxygen in combustion gas, as a percentage

	An alternate method of calculating the CO air free when access to an Oxygen meter is not available: $CO_{AFppm} = \times CO$ Where: UCO_2 = Ultimate concentration of carbon dioxide for the fuel being burned in percent for natural gas (12.2 percent) and LP gas (14.0 percent) CO_2 = Measured concentration of carbon dioxide in combustion products in percent CO = Measured concentration of carbon monoxide in combustion products in percent
Category I Vented Appliance	An appliance that operates with a *non-positive* vent static pressure and with a vent gas temperature that *avoids* excessive condensate production in the vent.
Category II Vented Appliance	An appliance that operates with a *non-positive* vent static pressure and with a vent gas temperature that *can cause* excessive condensate production in the vent.
Category III Vented Appliance	An appliance that operates with a *positive* vent static pressure and with a vent gas temperature that *avoids* excessive condensate production in the vent.
Category IV Vented Appliance	An appliance that operates with a *positive* vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent.
Central Furnace	A self-contained appliance for heating air by transfer of heat through metal to the air and designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.
Chimney	One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outdoors.
Chimney Flue	The passage(s) in a chimney for conveying the flue or vent gases to the outdoors.
Cold Vent/Warm Vent	Cold vent pertains to an appliance for which the heat setting is turned to OFF. Warm vent

	pertains to an appliance for which the heat setting is turned to ON.
Combustion Appliance Zone (CAZ)	Room and enclosed air volume that contains a combustion appliance. This may include, but is not limited to, a mechanical room, mechanical closet, or main body of the house.
Common Vent	That portion of a vent or chimney system that conveys products of combustion from more than one appliance.
Direct Vent Appliance	An appliance that is constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors.
Draft Hood	A draft hood acts as a pressure break between the vent system and the appliance and eliminates stack action. Without the draft hood, the vent could experience excessive draft, flame instabilities, and possibly pilot outage.
Duct Furnace	A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating. This definition applies only to an appliance that, for air circulation, depends on a blower not furnished as a part of the furnace.
Home	A place of residence
Informative Content	Informative content includes preliminary elements that identify the standard, introduce its content and explain its background, development, and relationship with other documents, or supplementary elements, such as informative annexes, that provide additional information intended to assist in the understanding or use of the standard.
Lower Explosive Limit (LEL)	The minimum concentration of combustible vapor or combustible gas in a mixture of the vapor or gas and gaseous oxidant above which propagation of flame will occur on contact with an ignition source. Also referred to as Lower Flammable Limit.

~~Listed Solid Fuels Appliance~~	~~Included in a list published by a recognized testing laboratory or inspection agency, indicating that the equipment meets nationally recognized safety standards. Equipment or materials tested to required standards by a testing organization acceptable to the "AHJ"; may be included in a list published by a model code organization acceptable to the "AHJ." Both organizations maintain periodic inspection of production of listed equipment or materials state that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.~~
~~Moisture Control Layer/s(s)~~	~~For the purposes of this standard, moisture control layer/s(s) refer to one or more of the following as they apply to various parts of the home: ground moisture barrier, capillary break, drainage plane, vapor control layer.~~
~~Normative Content~~	~~Normative content includes prescriptive elements that describe the scope of the standard and which set out provisions to be met in order to comply with the standard.~~
~~Spillage~~	~~Entry of combustion products into a building from dilution air inlets, vent connector joints, induced draft fan case opening, combustion air inlets, or other locations in the combustion or venting system of a vented combustion appliance (boiler, fireplace, furnace, or water heater), caused by backdrafting, vent blockage, or leaks in the venting system.~~
~~Steady State Efficiency~~	~~Measures how efficiently a furnace converts fuel to heat, once the furnace has warmed up and is running steadily.~~
~~Test Out~~	~~Post-installation diagnostics conducted at the conclusion of a job to gauge the effectiveness of air and duct sealing measures and to address health and safety issues that may be directly affected by the home performance work. Tests may include:~~

- Visual inspection of installed measures as specified in the statement of work, review of commissioning reports, and diagnostic tests as necessary to confirm that manufacturers' specifications and industry-accepted standards have been satisfied
- Combustion safety checks for all projects where improvements might impact combustion appliance performance
- Blower door tests when measures impacting infiltration rates are installed
- Zone pressure diagnostic tests verifying air sealing between occupiable space and attic, crawlspace and/or attached garage
- System airflow and/or static pressure tests when duct sealing measures are installed

Type B Gas Vent	A vent for venting gas appliances with draft hoods and other Category I appliances requiring Type B gas vents.
Unvented Room Heater	Category of unvented, self-contained, free standing, non recessed (except as noted) fuel gas burning appliance for furnishing warm air by gravity or fan without duct connection. Gas hearth appliances listed to ANSI Standard Z21.11.2 include Gas Fireplaces and Fireplace Inserts.
Vapor Retarder	A material that reduces the rate of water vapor transmission. Vapor retarders should be part of a moisture control strategy for a home. The International Residential Code (IRC) defines vapor retarders as Class I, II or III based on how permeable they are to water vapor, the lower the permeability – the less water vapor that will pass through the vapor retarder. A Class I vapor

~~retarder is often referred to as a vapor barrier.~~

Class	Definition	Examples
I	≤ 0.1 perm	Sheet polyethylene, sheet metal, non-perforated aluminum foil, foil-faced insulation sheathing
II	> 0.1 to < 1.0 perm	Kraft-faced fiberglass batts or low-perm paint, unfaced expanded polystyrene, fiber-faced polyisocyanurate
III	> 1.0 perm	Latex or enamel paint

Note this table is deleted

~~Vent~~ ~~A passageway used to convey flue gases from appliances or their vent connectors to the outdoors.~~

~~Vent Connector~~ ~~The pipe or duct that connects a fuel gas-burning appliance to a vent or chimney.~~

~~Vent Gases~~ ~~Products of combustion from appliance plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.~~

~~Venting~~ ~~The conveyance of combustion products to the outdoors.~~

~~Warm Vent/Cold Vent~~ ~~Cold vent pertains to an appliance for which the heat setting is turned to OFF. Warm vent pertains to an appliance for which the heat setting is turned to ON.~~

~~Annex C | BPI-1200-S-2017 Acronyms (Informative)~~

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

NOTE: This annex has been superseded by the National Laboratories of the Rockies (NLR) Standard Work Specifications: https://sws.nlr.gov/lexicon

~~Acronym~~	~~Meaning~~
~~ACCA~~	~~Air Conditioning Contractors of America~~
~~ACM~~	~~Asbestos-containing material~~
~~AMCA~~	~~Air Movement and Control Association~~
~~ANSI~~	~~American National Standards Institute~~
~~APSP~~	~~Association of Pool and Spa Professionals~~
~~ASHRAE~~	~~American Society of Heating, Refrigerating and Air-Conditioning Engineers~~
~~ASTM~~	~~ASTM International~~
~~BPI~~	~~Building Performance Institute, Inc.~~
~~CAS~~	~~Combustion appliance safety~~
~~CAZ~~	~~Combustion appliance zone~~
~~CFM~~	~~Cubic feet per minute~~
~~CO~~	~~Carbon monoxide~~
~~CO_2~~	~~Carbon dioxide~~
~~CSPC~~	~~United States Consumer Products Safety Commission~~
~~CSIA~~	~~Chimney Safety Institute of America~~
~~DOE~~	~~United States Department of Energy~~
~~EA~~	~~Energy auditing~~
~~EPA~~	~~United States Environmental Protection Agency~~
~~HRV~~	~~Heat recovery ventilator~~
~~HVAC~~	~~Heating, ventilation, and air conditioning~~
~~IECC~~	~~International Energy Conservation Code~~
~~NFPA~~	~~The National Fire Protection Association~~
~~NFI~~	~~National Fireplace Institute~~
~~NORA~~	~~National Oilheat Research Alliance~~
~~OSHA~~	~~Occupational Safety & Health Administration~~
~~Pa~~	~~Pascal~~
~~PPM~~	~~Parts per million~~
~~PV~~	~~Photovoltaic~~
~~RESNET~~	~~Residential Energy Services Network~~
~~SHGC~~	~~Solar heat gain coefficient~~
~~UL~~	~~Underwriters' Laboratories~~
~~VOCs~~	~~Volatile organic compounds~~
~~W.C.~~	~~Water Column~~
~~WRT~~	~~With reference to~~

~~Annex H | ANSI/ASPS/ICC 15 Energy Efficiency Compliance Information for Residential Swimming Pools (Informative)~~

Note this annex and worksheet is deleted and has been superseded by the Pool & Hot Tub Alliance. *Energy Efficiency Compliance Information for Residential Swimming Pools* (included in the References section).

~~[This Annex is not part of the standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It may contain material that has not been subject to ANSI requirements regarding public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at BPI or ANSI.]~~

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~~***Please see information sheet, ANSI/ASPS/ICC 15 Energy Efficiency Compliance Information for Residential Swimming Pools, beginning on the following page***~~.

APSP The Association of Pool & Spa Professionals®

ANSI/APSP/ICC 15 ENERGY EFFICIENCY COMPLIANCE INFORMATION FOR RESIDENTIAL SWIMMING POOLS					
PROJECT NAME: AND ADDRESS			CONTRACTOR NAME AND ADDRESS:		
OWNER:			CONTRACTOR PHONE:	DATE:	

This information sheet was prepared by the APSP-15 Residential Swimming Pool and Spa Energy Efficiency Standard Writing Committee of the Association of Pool and Spa Professionals (APSP). It is not part of the American National Standard ANSI/APSP/ICC-15 2011 but is included for information only. Contractors should acquire and comply with the ANSI/APSP/ICC-15 2011 standard which can be purchased at www.apsp.org.

1. §5.2.1: Calculated pool volume

a. Gallons: _____ ; or

b. *Calculated Gallons:* _____*(surface area) X* _____ *(average depth) X 7.48 (gal/ft^3)* = _____

1. _____ gallons ___

2. §5.2.1: Calculated maximum filtration flow rate

(Pool volume ÷ 360 or 36gpm whichever is larger)

2. _____ gpm ___

3. §5.2.2: Auxiliary Pool Load: ____Yes, ____No?

(Enter the highest "auxiliary pool load" to be powered by the swimming pool filtration pump. Do not add auxiliary pool load flow rates together, only the highest is used.)

3. _____ gpm ___

4. Calculated maximum flow rate

(Item 2 or item 3, whichever is larger.)

4. _____ gpm ___

Note this annex and worksheet is deleted and has been superseded by the Pool & Hot Tub Alliance. *Energy Efficiency Compliance Information for Residential Swimming Pools.*

5. §5.5.1: Pipe sizing:

a. Minimum suction pipe diameter

(Enter the smallest pipe size from Table 1 with a 6 fps flow

5a. _____ inches ___

b. Minimum suction branch pipe diameter

(Calculate: Item 4. _____(gpm) ÷ Branch Pipes _____(q
Enter the smallest pipe size from Table 1 with a 6 fps flow
suction branch flow rate.)

5b. _____ inches ___

c. Minimum return pipe diameter

(Enter the smallest pipe size from Table 1 with a 8 fps flow capacity the same or more than item 4.)

5c. _____ inches ___

d. Minimum return branch pipe diameter

(Calculate: Item 4. _____(gpm) ÷ Branch Pipes _____(quantity) = branch flow rate _____(gpm).
Enter the smallest pipe size from Table 1 with a 8 fps flow capacity the same or more than the calculated return branch flow rate.)

5d. _____ inches ___

6. §5.4.1: Filter type and size:

a. Filter type: *(Cartridge, DE, Sand)*

6a. _____ ___

b. Minimum filter area

(Calculate: item 4. _____(gpm) ÷ filter factor _____)
Filter factors: Cartridge=0.375, Sand=15, Diatomaceous Earth=2

6b. _____ sq. ft. ___

7. §5.4.2: Backwash valve: ____Yes, ____No?

(When using a backwash valve, enter result of item 5c or 2 inches whichever is larger)

7. _____ inches ___

Table 1

Pipe Size:	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"
Nominal GPM @ 6 fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8 fps	51	84	119	184	247	317	499	720

8. Pump selection:

§5.3.2.1: Pools 17,000 gallons or less, select pump from the database with a Curve-A gpm flow equal to item 2 or less.*
§5.3.2.2: Pools 17,001 gallons or more, select pump from the database with a Curve-C gpm flow equal to item 2 or less. *Multi-speed pumps must have one speed listed that satisfies this requirement.*

a. Pump model

8a. _____ ___

b. Pump flow

(§5.3.2.1, 5.3.2.2: Applicable Curve A or C gpm flow listed in database)

8b. _____ gpm ___

ANSI/APSP/ICC 15 ENERGY EFFICIENCY COMPLIANCE INFORMATION FOR RESIDENTIAL SWIMMING POOLS

Component	Section	Requirements	Check
Heaters	4.4.1.1	Heater has no pilot light	
	4.4.1.2	Readily accessible on-off switch mounted outside of the heater	
	4.3.1.3	No electric resistance heating unless for inground spa with tight fitting cover with R-6 insulation, or for pool with 60% of documented pool heating from on-site solar or recovered energy.	
	4.3.2	Heater efficiency 8%, heat pump COP at least 4.0	
Pool systems	5.1.1	Pool filter pump	
	5.3.1	Pool filter pump lti-speed	
	5.3.3	Multi-speed pum he filtration flow rate when no auxiliary pool loads are op d with temporary override capability for servicing.	
	5.3.4	Single-speed pump controller capable of operating pump during off-peak electric demand.	
	5.5.2	Pipe before pump has at least 4 diameters of straight pipe.	
	5.5.3	System installed with solar, or setup for the future addition of solar heating equipment by installing 18 inches of horizontal or vertical pipe after the filter and before a heater, or built-in or built-up connections, or dedicated pipe to and from the pool.	
	5.5.6	Directional inlets for mixing pool water.	

Note this annex and worksheet is deleted and has been superseded by the Pool & Hot Tub Alliance. *Energy Efficiency Compliance Information for Residential Swimming Pools.*

~~Annex E | Minimum Clearances to Combustible Materials (Normative)~~

~~Table E.1. Minimum Clearances (in inches) to Combustible Materials for Unlisted Furnaces and Boilers~~

~~Appliance~~	~~Above and Sides of Furnace Plenum~~	~~Top of Boiler~~	~~Jacket Sides and Rear~~	~~Front~~	~~Draft Hood and Barometric Draft Regulator~~	~~Single-Wall Vent Connector~~
~~1. Automatically fired, forced air or gravity system, equipped with temperature limit control that cannot be set higher than 250°F (121°C)~~	~~6~~	~~—~~	~~6~~	~~18~~	~~6~~	~~18~~
~~2. Automatically fired heating boilers—steam boilers operating at not over 15 psi (103 kPa) and hot water boilers operating at 250°F (121°C) or less~~	~~6~~	~~6~~	~~6~~	~~18~~	~~18~~	~~18~~
~~3. Central heating boilers and furnaces, other than I or II.~~	~~18~~	~~18~~	~~18~~	~~18~~	~~18~~	~~18~~
~~4. Air-conditioning appliances*~~	~~18*~~	~~18~~	~~18~~	~~18~~	~~18~~	~~18~~

~~*Where supply ducts are within 3 ft. feet (0.9 m) of the furnace plenum, listed air conditioning equipment shall have clearances no less than that specified from the furnace plenum.~~

Note: Table E.1 has been removed. Table E.2 has been revised and moved to Section 7 of the draft.

Table E.2. Minimum Clearances to Combustible Materials for Vent Connectors Attached to Appliances with Draft Hoods (in inches)	
Vent Material	Minimum Clearance
Type B Gas Vent	6
Type L Vent	6
Single Wall Metal Pipe	9

Note: Table E.1 has been removed. Table E.2 has been revised and moved to Section 7 of the draft.

Annex G | BPI-1200-S-2017 Relevant Resources (Informative)

NOTE: This annex has been replaced by an Additional Reading section in BPI-1200, beneath the References section.

Item	Date	Relevant Section of BPI-1200
ANSI/APSP/ICC-15a 2013 American National Standard for Residential Swimming Pool and Spa Energy Efficiency *Document can be ordered at:* APSP: Association of Pool and Spa Professionals 2111 Eisenhower Ave., Alexandria, VA 22314 www.apsp.org	2013	Section 12
ASTM E241–09(2014)e1 Standard Guide for Limiting Water-Induced Damage to Buildings Document can be ordered at: ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959 www.astm.org	2014	Section 9

National Center for Healthy Housing/American Public Health Association *National Healthy Housing Standard* *Section 6.1, Moisture Prevention and Control* http://www.nchh.org/Portals/0/Contents/NHHS_Full_Doc.pdf	2014	Section 9
National Institute of Building Sciences *Whole Building Design Guide -* *Mold and Moisture Dynamics* http://www.wbdg.org/resources/moisturedynamics.php	2015	Section 9
U. S. Consumer Products Safety Commission (CPSC) Responding to Residential Carbon Monoxide Incidents: Guidelines for Fire and Other Emergency Response Personnel http://www.cpsc.gov//PageFiles/121994/coguide.pdf	2000	Section 7
U.S. Department of Housing and Urban Development *Durability by Design – A Guide for Residential Builders and Designers* *A Professional's Guide to Durable Home Design* *Chapter 3, Ground and Surface Water* *Chapter 4, Rain and Water Vapor* http://www.huduser.org/portal//Publications/pdf/durability_by_design.pdf	2002	Section 9
U.S. Environmental Protection Agency A Citizen's Guide to Radon http://www.epa.gov/radon/pdfs/citizensguide.pdf	2012	Section 3

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[12] *ANSI/ASHRAE Standard 62.2-2025: Ventilation and Acceptable Indoor Air Quality in Residential Buildings.* American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), 2022.

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[14] ASTM E779-19: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization. ASTM International, 2019.

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