



ANSI/BPI-1200-S-2017

STANDARD PRACTICE FOR BASIC ANALYSIS OF BUILDINGS



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This standard has been formulated under the cognizance of the BPI Standards Technical Committee.

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 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.

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1 Scope

- 1.1 This standard practice defines the minimum criteria and specific procedures for conducting building science-based residential energy audits and related diagnostic tests.
- 1.2 The energy audit and related diagnostic tests will address energy usage, and limited aspects of building durability and occupant health and safety. The energy audit will provide a comprehensive report with a list of prioritized recommendations to improve the home and will include a cost benefit analysis.
- 1.3 Residential building types covered are defined as existing detached single-family dwellings and townhouses that:
 - 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 Home Energy Auditing Standard* (BPI-1100) and provides specific procedures regarding how to meet the requirements detailed in BPI-1100.

2 General Requirements

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

3 Health and Safety Related Requirements

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

4 Disclosure and Ethics

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

5 Cost Benefit Analysis

The auditor shall comply with the requirements detailed in *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.
- 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 of *Procedures for Certifying Residential Energy Efficiency Tax Credits – RESNET Publication No. 13-001, January 15, 2013.*
- 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 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 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 sections 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)*, 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 installed ECMs using one of the following procedures:
 - 5.7.1 ANSI/BPI-2400
 - 5.7.2 Other methods approved by the AHJ

6 Prioritizing Recommendations

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

7 Combustion Appliance and Fuel Distribution System Inspection

The auditor shall comply with the requirements detailed in *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)
 - CGD equipment used for testing shall:
 - 7.1.1.1 Be classified to *UL 913 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 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 Be capable of providing a digital display of percentage of Lower Explosive Limit (LEL) and/or provide an alarm when detecting combustible gas concentrations exceeding 10% Lower Explosive Limit (LEL).

7.1.1.4 Be calibrated and/or operation checked in accordance with the manufacturer's recommendations with available documentation traceable to the individual device.

7.1.1.5 Have the ability to zero ambient conditions.

7.1.2 CO measurement equipment

Equipment/instruments used for flue gas CO measurement shall:

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

7.1.2.2 Be capable of calculating and displaying digitally, CO air free concentrations, or have digital displays of CO as measured and O² levels to allow manual calculation of CO air free.

7.1.2.3 Have a resolution of 1 ppm.

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

7.1.2.5 Be equipped internally or externally with a nitric oxide filter (NO_x filter).

7.1.2.6 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 Pa or better and an accuracy of +/- 1% of pressure reading or +/-0.25 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 7.3.3.3.1) shall further work be undertaken.

- 7.3.1 CGD, ambient CO monitors, and CO measurement
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 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

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 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

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

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- 7.3.3.2.1 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 The auditor shall continue to monitor CO levels in the ambient air at all times while in the work environment.
- 7.3.3.3 Indoor ambient CO action levels
 - Actions in response to ambient CO measurements shall be taken as follows:
 - 7.3.3.3.1 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 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.
 - 7.3.3.3.3 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.

7.4 Order of inspection procedures

After the auditor has verified that combustible fuel gases are below 10% of the LEL (per section 7.3.2.) and that ambient CO readings are below 70 ppm (per 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 Natural Gas and Liquid Petroleum (LP) Gas Piping System Inspection
- 7.4.2 Oil Supply System Inspection
- 7.4.3 Visual Inspection of Combustion Appliance Zone (CAZ)
- 7.4.4 Combustion Appliance Safety Inspection
- 7.4.5 Solid Fuel Burning Appliance Inspection
- 7.4.6 Placing Appliances Back in Operation

7.5 Natural gas and LP gas piping system inspection

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 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 local authority having jurisdiction (AHJ), shall be tested in accordance with Annex C of *ANSI Z223.1/NFPA 54, Suggested Method for Checking for Leakage*.

Alternatively, the auditor shall conduct the following inspection tasks:

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

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 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 In the absence of manufacturer instructions, perform gas leak testing as follows:

7.5.2.2.1 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 Move the CGD wand along the entire gas line at a rate of 1" 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" per second.

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

7.5.2.3 The gas leakage inspection shall include the following components:

7.5.2.3.1 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.

7.5.2.3.2 Appliance gas valve/regulator housing and connections.

7.5.2.4 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 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 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.

7.5.2.7 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 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 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

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 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 Inspect the oil tank, if safely accessible, for evidence of historic or active oil spills or leakage.
- 7.6.3 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 Verify that the fill cap is in place and in good condition.
- 7.6.5 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 Verify the presence of a working shutoff at the tank.

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

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- 7.6.7 Verify that all lines properly connect to the tank.
- 7.6.8 Verify that exposed portions of the fuel line are protected from damage.
- 7.6.9 Fuel Oil Supply System - Action Levels
 - 7.6.9.1 In the case of a leak, the auditor shall:
 - 7.6.9.1.1 Mark the leak location and notify the homeowner/occupant.
 - 7.6.9.1.2 Advise the homeowner/occupant to contact a qualified professional to repair the leak.
 - 7.6.9.1.3 Follow specific rules and regulations pertaining to the local jurisdiction.
 - 7.6.9.2 The auditor shall document compliance or deficiencies on:
 - 7.6.9.2.1 Project documentation
 - Or
 - 7.6.9.2.2 National Oilheat Research Alliance's *Routine Fuel Oil Storage Tank Evaluation – Above Ground Tanks Checklist*, and include with project documentation
- 7.7 Visual inspection of combustion appliance zone (CAZ)
 - 7.7.1 Inspect the CAZ to determine if the area is free of the storage of gasoline or any flammable products such as oil-based solvents, varnishes or adhesives. Inspect the immediate area where the appliance is located to determine if the area is free of rags, paper or other combustibles
 - 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 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.
 - 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 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" above the floor unless listed as flammable vapor ignition resistant (FVIR). Advise homeowner/occupant of unsafe condition and note in project documentation.
- 7.8 Visual inspection of combustion appliance/s and venting system/s

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

7.8.1 Oil-fired, natural gas or LP gas appliances

7.8.1.1 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 ¼" rise per linear foot.

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

7.8.1.3 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 Inspect vent termination and verify presence of vent cap (if applicable and safely accessible).

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

7.8.1.6 Verify the blower compartment door, filter rack door and covers are properly installed.

7.8.1.7 Wiring: Inspect for bare wires, open connection or worn insulation.

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

7.8.2 Direct vent appliances

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

7.8.2.2 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 Inspect plastic venting system to determine that it is free of sagging and is sloped in an upward direction to the outdoor vent termination.

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

7.8.2.5 If deficiencies are identified per Sections 7.8.2.1-7.8.2.4, recommend further inspection by a qualified professional.

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

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

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

7.8.3.1.2 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 Combustion appliances vented into a common horizontal vent connector

7.8.3.2.1 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 Unvented heaters

7.8.4.1 Check appliance for *ANSI Z21.11.2 –Gas Fired Room Heaters-Volume II* (ANSI Z21.11.2) label.

7.8.4.2 Recommend removal of any unvented heater that is not listed to *ANSI Z21.11.2*.

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

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

7.8.4.5 Inform clients of potential dangers of unvented space heaters (CO, moisture, oxygen depletion, NO₂), and how these effects could become exacerbated with changes to the building envelope.

7.9 Combustion appliance safety inspection

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 CO measurement and spillage assessment on natural draft appliances equipped with a barometric draft control 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, direct-vent and vent-free combustion equipment. ***Ambient CO shall be monitored at all times during the test and actions taken as per Section 7.3.3.3 of this document.***

7.9.1 Set-up for conducting 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.

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- 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.³
- 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.

³ 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.

7.9.2 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.

7.9.3 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.

7.9.4 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 Combustion appliances shall be tested in order from lowest BTU_h input rating to highest BTU_h input rating.

7.9.4.2 The appliance with the lowest BTU_h input rating shall be assessed for spillage and CO measurement in undiluted flue gas shall be conducted in accordance with Section 7.9.2 (Cold Vent) or 7.9.3 (Warm Vent) of this document.

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

7.9.4.4 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 Measure 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 BTU_h input rating until all are running simultaneously.

7.9.4.6 CO measurements shall be compared with the appropriate CO thresholds in Section 7.9.5, 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 ⁴
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 Direct-vented and power-vented appliances

7.9.6.1 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.

7.9.6.2 The CO measurement/s shall be compared with the appropriate CO threshold/s in Section 7.9.5, Table 1.

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

7.9.7 Gas ovens and range tops

⁴ See Carbon Monoxide Air Free in Annex B |Terms and Definitions for further details.

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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 With appliance off, complete the following visual inspection:

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

7.9.7.1.2 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 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 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 Inspect range top burners for cleanliness. If the burners are excessively dirty, recommend that they be cleaned to reduce the possibility of unacceptable emissions.

7.9.7.2 Turn the oven on to a bake temperature 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 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 undiluted CO.

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

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

7.9.7.3 Actions 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.

7.9.8 Unvented combustion heating or hearth appliance CO inspection procedures

7.9.8.1 Unvented heaters

7.9.8.1.1 With the appliance on, measure CO after 5 minutes of main burner operation. Compare the CO measurement with the appropriate threshold in Section 7.9.5, Table 1.

7.9.8.1.2 Actions 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.

7.9.8.2 Gas log sets

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- 7.9.8.2.1 With the appliance off, if gas logs are installed in wood burning fireplaces equipped with a damper, verify that the fireplace damper is in a fixed open position.
- 7.9.8.2.2 With the appliance on, measure CO 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, Table 1.
- 7.9.8.2.3 Actions 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.

7.10 Solid fuel burning appliance inspection

- 7.10.1 The auditor shall perform the following visual inspection and 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 Identify the listing nameplate on the appliance and record the model name and model number, if available.
 - 7.10.1.2 Determine through homeowner/occupant interview if the appliance is the primary heating source.
 - 7.10.1.3 If the appliance is the primary heating source, determine when the chimney and vent connector were last cleaned and inspected. If they have not been cleaned and inspected within the past year, recommend servicing by a certified hearth professional.
 - 7.10.1.4 Visually inspect and note the type and condition of flooring material where the appliance is installed.
 - 7.10.1.5 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:
 - 7.10.1.5.1 Appliances installed on carpets, wood floors or other combustibles.
 - 7.10.1.5.2 Inadequate clearance to combustible materials. Consult the appliance documentation for required clearances. If no documentation is available, refer to NFPA 211.
 - 7.10.1.5.3 Signs of structural failure, such as cracks or broken welds, of any components.
 - 7.10.1.6 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.

Alternatively, the auditor shall follow the procedure below to inspect wood burning or pellet burning appliances and inserts:

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

7.11 Placing appliances back in operation

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 actions levels specified in the preceding 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 *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 ventilation system documentation provided by the equipment manufacturer, system designer or installer that could identify the type of systems, location, designed and tested performance, and/or specifications of the equipment.
- 8.2 Determine the whole-building ventilation requirements in accordance with *ANSI/ASHRAE 62.2-2013: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings* (ASHRAE 62.2). (See Annex I, 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 *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 *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 *BPI-1100*, Section 8.2.
 - 8.3.3 In situations identified in *BPI-1100*, Section 8.3 where exhaust fan or clothes dryer* vents terminate within the building enclosure, including any unconditioned attics or crawl spaces, 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.

*Exception: condensing exhaust dryers.

- 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.

9 Moisture Control

The auditor shall comply with the requirements detailed in *BPI-1100*, Section 9, Moisture Control.

10 Building Enclosure

The auditor shall comply with the requirements detailed in *BPI-1100*, 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 enclosure for cost-benefit analysis and prioritization, detailed measurements of components and insulation levels 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.
 - 10.1.1.2 Throughout the evaluation, note the presence of hazards or potential hazards such as knob and tube wiring.
 - 10.1.2 Foundation
 - 10.1.2.1 Note the foundation type(s) (e.g., slab on grade, crawl space, basement), construction type (e.g., stone, brick, poured concrete), location of the thermal boundary, and exposure above grade. When feasible, note location and condition of the pressure boundary and the moisture 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 degradation or installation issues with existing insulation.
 - 10.1.2.4 Note any thermal bypasses observable from the basement or crawl space(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 When home energy upgrades for foundation insulation are proposed, indicate the surface area(s) and construction type, recommended effective 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 barrier, thermal barrier, air barrier, and drainage plane (as applicable).

10.1.3 Walls

10.1.3.1 Note the wall construction type(s) that comprise the thermal boundary, and indicate insulation presence and type. Insulation and construction details within a structure vary depending on construction type, age of construction, interior or exterior renovations or retrofits; it may be necessary to inspect multiple areas of wall using 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 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 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).

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.

10.1.3.4.2 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 damaged or meter is not properly anchored to building.

10.1.3.5.2 Note if outdoor electric receptacle is not GFCI or lacks weather-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. Insulation and construction details within a structure vary depending on construction type, age of construction, interior or exterior renovations or retrofits; it may be necessary to inspect multiple areas of floor using 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 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).

10.1.5 Attics

10.1.5.1 Note the attic or roof type(s) (e.g., rafter/joist, truss, vaulted ceiling), and location of the thermal boundary. When feasible, note location and condition of the pressure boundary and the moisture barrier.

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, of any insulation on attic ceiling (rafters) and/or floor joists), as well as any degradation or installation issues with existing insulation.

10.1.5.4 Note the presence, type, 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.

10.1.5.5 Where there is no attic access it may be necessary to inspect multiple areas of attic or vaulted ceiling using a combination of methods (e.g., visual inspection, non-conductive probe, boroscope, and/or non-destructive imaging) to determine insulation recommendations.

10.1.5.6 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).

10.1.5.7 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). 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.

10.1.5.8 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 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, including the verification of an effective air 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 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 When home energy upgrades for sealing air leaks are proposed, include the following information:

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

10.2.2.2 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 When air sealing is recommended, include a recommendation that post-installation air leakage testing be conducted to verify air sealing results.

10.3 Evaluate Fenestration

10.3.1 Identify predominant window and skylight characteristics:

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

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

10.3.1.3 Significant shading, interior or exterior

10.3.1.4 Condition and operation

10.3.1.5 Where deficiencies are noted, recommend repair or replacement with windows that meet or exceed ENERGY STAR® specifications. 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 Evaluate exterior door characteristics

10.3.2.1 Determine whether the door is insulated.

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

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

10.3.2.4 Where deficiencies are noted, recommend repair or replacement with doors that meet or exceed ENERGY STAR® specifications. 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 Evaluate solar heat gain

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

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

10.5 Project documentation shall include:

10.5.1 Enclosure leakage

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

10.5.2 Enclosure thermal performance

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

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

10.5.2.3 Recommendation of insulation retrofits when cost-effective.

10.5.3 Enclosure cooling loads

10.5.3.1 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.

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

10.5.4 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*, 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)*, or the manufacturer's instructions, or by procedures accepted by 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 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 furnace. Complete a visual inspection of the forced-air furnace and document information as noted in this section.
- 11.2.1 Note condition of the furnace cabinet, removable panels. If panels are loose/missing make recommendation to install/replace/repair.
 - 11.2.2 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 Note the condition of the system filter. If no filter exists or it is in poor condition, make recommendation to install/replace.

- 11.2.4 Note the condition of the system 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.
 - 11.2.5 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.
 - 11.2.6 If furnace model 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. Complete a visual inspection of the air conditioning and heat-pump and document information as noted in this section.
- 11.3.1 Examine the outdoor coil cabinet.
 - 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 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 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.
 - 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.

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- 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 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 contain dirt buildup, recommend cleaning and servicing by a qualified professional as specified in *ANSI/ACCA 6-2007: Restoring the Cleanliness of HVAC Systems*.
- 11.3.5 If a humidifier 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/air conditioner. Complete a visual inspection of the ductless mini-split heat pump/air conditioner and document information as noted in this section.
 - 11.4.1 Examine the outdoor coil cabinet 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.
 - 11.4.4 Examine the inside of the air handler cabinet per 11.3.4.
- 11.5 Evaluate packaged terminal air conditioner. Complete a visual inspection of the packaged terminal air conditioner and document information as noted in this section.
 - 11.5.1 Examine the condition and the installation of the 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 build up, 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. Complete an inspection of the air distribution system and document information as noted in this section.
 - 11.6.1 Visually inspect ducts, plenums and distribution boxes outside the thermal boundary to verify presence and condition of insulation. In humid climates, verify presence and condition of insulation on metal ducts and plenums located inside the thermal boundary.
 - 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 crawl spaces. 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*, 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 Qualitative testing using a gasketed pan in accordance with the manufacturer's instructions and in conjunction with a blower door.

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

11.6.3.1 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 *ACCA Standard 5: HVAC Quality Installation Specification (ANSI/ACCA 5 QI-2010)*. When these limits are exceeded, duct sealing shall be recommended.

11.6.3.2 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.

11.6.3.3 When duct sealing is recommended, a recommendation for post-installation total external static pressure measurement by a qualified professional shall be included.⁵

⁵ 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 catastrophic failure of the heating or cooling equipment.

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- 11.6.4 Ducts shall be visually 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. Complete a visual inspection of the evaporative cooler and document information as noted in this section.
 - 11.7.1 Examine the evaporative cooler exterior housing installation and condition. Evaluate the clearance around the unit and document all obstructions to airflow.
 - 11.7.2 Check the bleed tube or sump pump for the presence of dirty water or clogging.
 - 11.7.3 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. Complete a visual inspection of the steam-heating boiler and document information as noted in this section.
 - 11.8.1 Inspect for evidence of water leakage, build-up of deposits, and/or corrosion at the appliance and local 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 if water had to be added to or removed from the boiler during the heating season. If water has been added or removed, recommend that the system be serviced by a qualified professional.
 - 11.8.4 Verify presence of a low water cutoff. If no low water cut-off is present, recommend installation by a qualified professional.
 - 11.8.5 Verify the presence of the temperature/pressure relief (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.
 - 11.8.6 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. Complete a visual inspection and document information as noted in this section.

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- 11.9.1 Examine the insulation on the steam-heating 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.
 - 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 leaks. If leaks are noted, recommend repair by a qualified professional.
 - 11.9.4 Inspect for missing or damaged vents on radiators. 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 not producing heat. If any radiator does not produce heat, recommend the system be serviced by a qualified professional. Place boiler control to original setting.
- 11.10 Evaluate the forced hot-water space heating appliance. Complete a visual inspection of the forced hot water space heating appliance 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 presence of an automatic feeder valve. 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 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.
 - 11.10.4 Verify the presence 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 noted, recommend boiler be serviced by a qualified professional.

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- 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. Complete a visual inspection and document information as noted in this section.
 - 11.11.1 Document the number and location of circulating pumps and/or zone valves and location of the thermostats/operating controls for each pump/zone.
 - 11.11.2 Inspect the fin tubes of the heat emitters, 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 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. Place appliance thermostat or control to original setting.
- 11.12 Evaluate the domestic water heater. Complete a visual inspection of the water heater and document information as noted in this section.
 - 11.12.1 Note the location, type, and general condition of the domestic water heater.
 - 11.12.2 Inspect for soot, debris, or signs of spillage around flue collar, barometric draft control, or draft hood. If noted, recommend water heater be serviced by a qualified professional.
 - 11.12.3 Verify the presence and condition of tank insulation wrap. If tank 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 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 Verify the presence of pipe insulation, noting type and location. 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 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. If leaks are evident, recommend that the appliance be replaced with a high efficiency appliance installed 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. If the model number and date of manufacture cannot be determined, record the type and approximate age for each appliance. When replacement is recommended 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 each appliance. When replacement is recommended 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 changing to a less expensive fuel source would result in cost savings. Ensure that the dryer vents to the exterior and is not constricted with lint. If the dryer is vented with plastic ductwork, recommend replacement with all-metal ducts.
 - 12.1.4 Record existing high-use lighting and make recommendations for lighting efficiency, including compact fluorescent or LED light bulbs, and hardwire fluorescent or LED fixtures, where appropriate.
 - 12.1.5 Recommend, and educate homeowner/occupant about, smart power strips for plug load clusters such as an entertainment center or home office, and/or upgrading to units that meet or exceed ENERGYSTAR[®] specifications.
- 12.2 Pools, spas⁶, and portable hot tubs
 - 12.2.1 Residential pools or inground spas

⁶ Swimming pools, spas, and hot tubs can use large amounts of energy and greatly skew household baseload use if not accurately accounted for.

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).⁷

12.2.1.2 Note: Additional guidance for residential pool and spa inspection can be found in 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-14 2011, Standard for Portable Electric Spa Energy Efficiency* (ASPS-14). If the spa is not labeled, recommend replacement with an ASPS-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 relevant.

12.4 Estimate the baseload.

12.4.1 Estimating the baseload 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 from 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:

⁷ 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.

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

$$\text{Annual gas baseload} = 12 \times 1.1 \times (\text{average of three lowest months' therms})$$

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

$$\text{Annual electricity baseload} = 12 \times 1.1 \times (\text{average of the three lowest months' kWh})$$

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: $12 \times 1.1 \times (\text{average of the three lowest months of gallons used}) = \text{baseload}$. Note: The degree of uncertainty in establishing non-grid connected baseload increases as the number of fuel delivery records decreases.

13 Water Conservation

The evaluation shall include an assessment of potential water conservation measures based on the following observations.

- 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 ENERGYSTAR® 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 A | BPI-1200-S-2017 Referenced Documents (Normative)

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

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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.tpsqc-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.]

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 (<i>ASHRAE 62.2-2013</i> 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)	<p>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.</p> <p>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.</p> <p>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</p>

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 (BTU)

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. BTU_h 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 O₂ percentage:

$$CO_{AFppm} = \left(\frac{20.9}{20.9 - O_2} \right) \times CO_{ppm}$$

Where:

CO_{AFppm} = Carbon monoxide, air-free ppm

CO_{ppm} = As-measured combustion gas carbon monoxide ppm

O₂ = 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:

$$CO_{AFppm} = \left(\frac{UCO_2}{CO_2} \right) \times CO$$

Where:

UCO₂ = Ultimate concentration of carbon dioxide for the fuel being burned in percent for natural gas (12.2 percent) and LP gas (14.0 percent)

CO₂ = 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

	<p>pertains to an appliance for which the heat setting is turned to ON.</p>
Combustion Appliance Zone (CAZ)	<p>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.</p>
Common Vent	<p>That portion of a vent or chimney system that conveys products of combustion from more than one appliance.</p>
Direct Vent Appliance	<p>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.</p>
Draft Hood	<p>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.</p>
Duct Furnace	<p>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.</p>
Flue Gases	<p>Products of combustion plus excess air in appliance flues or heat exchangers.</p>
Home	<p>A place of residence</p>
Informative Content	<p>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.</p>
Lower Explosive Limit (LEL)	<p>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</p>

	<p>an ignition source. Also referred to as Lower Flammable Limit.</p>
Listed Solid Fuels Appliance	<p>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.</p>
Normative Content	<p>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.</p>
Spillage	<p>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.</p>
Steady State Efficiency	<p>Measures how efficiently a furnace converts fuel to heat, once the furnace has warmed up and is running steadily.</p>
Test Out	<p>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:</p> <ul style="list-style-type: none">• 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.

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.]

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

BPI – Building Performance Institute, Inc.

CAS – Combustion appliance safety

CAZ – Combustion appliance zone

CFM – Cubic feet per minute

CO – Carbon monoxide

CO₂ – Carbon dioxide

CSPC – United States Consumer Products Safety Commission

CSIA – Chimney Safety Institute of America

DOE – United States Department of Energy

IECC – International Energy Conservation Code

EA – Energy auditing

EPA – United States Environmental Protection Agency

HRV – Heat recovery ventilator

HVAC – Heating, ventilation, and air conditioning

NFI – National Fireplace Institute

NFPA – National Fire Protection Association

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

D.1 Spillage assessment and CO measurement 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
- CO level at or below threshold in Section 7.9.5, Table 1 for the appliance being tested is ACCEPTABLE
- CO level exceeding threshold in Section 7.9.5, Table 1 for the appliance being tested is UNACCEPTABLE

<p align="center">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.</p>	
TEST RESULT	ACTION REQUIRED
Greatest CAZ depressurization occurs with the air handler on*	Conduct further analysis of the distribution system to determine if leaky ducts 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 <i>ANSI Z223.1/NFPA 54</i> for gas-fired appliances and <i>NFPA 31</i> 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
<p>*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.</p>	

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 | 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 which cannot be set higher than 250°F (121°C)	6	N/A	6	18	6	18
2. Automatically fired heating boilers—steam boilers operating at not over 15 psi and hot water boilers operating at not in excess of 250°F (121°C)	6	6	6	6	18	18
3. Central heating boilers and furnaces, other than 1. or 2.	18	18	18	18	18	18
4. Air-conditioning appliances*	18*	18	18	18	18	18

*Where supply ducts are within 3 ft. (0.9 m) of the furnace plenum, listed air conditioning equipment shall have clearances no less than that specified from the furnace plenum.

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

Annex F | 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.

1. How long have you lived here?
2. How many adults reside in the home?
3. How many children reside in the home?
4. What type of heating system do you have?
 - a. Fuel type?
 - b. Cost per unit of fuel?
 - c. How old is the heating system?
 - d. When was the last service/clean and tune?
5. Forced-Air Furnaces
 - a. Do you regularly change your furnace filter?
 - b. Date of last filter change?
6. Steam-Heating Boiler
 - a. Have you had to add more than a small amount of water to the boiler during the heating season?
7. Steam-Heating Boiler Distribution System
 - a. Do all radiators get hot?
 - b. Does the relief valve discharge?
 - c. Do you hear loud banging noises from the radiators or pipe?

8. Forced hot-water space heating appliance
 - a. Do all radiators get hot?
 - b. Does the relief valve discharge?
 - c. Does the system need to be bled periodically?
9. Do you use other appliances for comfort heating?
 - a. What type?
 - b. Fuel type?
 - c. Location in the house?
10. 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. 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. Do you have the owners' manual or installation guide for the appliance?
13. Does your home have cold rooms or areas?
 - a. Where and when does this occur?
14. Does your home have rooms or areas that are too warm?
 - a. Where and when does this occur?
15. Are there drafty areas in your home?
 - a. Where and when does this occur?

16. Thermostat type and location?
 - a. What is the highest setting you use?
 - b. What is the lowest setting you use?
17. Do you close off any rooms to prevent heating them?
18. Do any occupants suffer from headaches, flu, colds, or nausea during the heating season?
19. Is there a known moisture or condensation problem in the home?
 - a. Where and when does this occur?
20. Is there any known mold/mildew issue in your home?
 - a. Where and when does this occur?
21. Are you aware of lead paint or asbestos in your home?
22. Has your home been tested for radon?
23. Does the basement get wet at anytime during the year?
24. Have you experienced any evidence of poorly operating pumps, such as short cycling, unusual odors, or low water pressure?
25. Does ice form on the eaves or in the attic during winter?
26. Does your roof leak during any time of the year?
27. Do you have an air conditioner?
28. Are there windows or doors that are hard to open or close?
29. Are there any known electrical issues (e.g., knob and tube wiring)?
30. How many loads of laundry do you wash/dry per day (or week)?
31. Approximately how many showers/baths per day?
32. Do you have functioning smoke alarms?
 - a. How many?
 - b. Where are they located?

33. Do you have functioning CO alarms?
 - a. How many?
 - b. Where are they located?
34. Are there specific health and safety or comfort issues you would like to discuss?
35. Are there any major renovations, such as additions, remodeling kitchens or bathrooms, finishing of basement or attic, planned in the next 12 months?

Annex G | BPI-1200-S-2017 Relevant Resources (Informative)

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Item	Date	Relevant Section of BPI-1200
<p><i>ANSI/APSP/ICC-15a 2013 American National Standard for Residential Swimming Pool and Spa Energy Efficiency</i></p> <p>Document can be ordered at:</p> <p>APSP: Association of Pool and Spa Professionals 2111 Eisenhower Ave., Alexandria, VA 22314 www.apsp.org</p>	2013	Section 12
<p><i>ASTM E241–09(2014)e1 Standard Guide for Limiting Water-Induced Damage to Buildings</i></p> <p>Document can be ordered at:</p> <p>ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959 www.astm.org</p>	2014	Section 9
<p>National Center for Healthy Housing/American Public Health Association</p> <p><i>National Healthy Housing Standard</i></p> <p>Section 6.1, Moisture Prevention and Control http://www.nchh.org/Portals/0/Contents/NHHS_Full_Doc.pdf</p>	2014	Section 9
<p>National Institute of Building Sciences</p> <p><i>Whole Building Design Guide - Mold and Moisture Dynamics</i></p> <p>http://www.wbdg.org/resources/moisturedynamics.php</p>	2015	Section 9
<p>U. S. Consumer Products Safety Commission (CPSC) <i>Responding to Residential Carbon Monoxide Incidents: Guidelines for Fire and Other Emergency Response Personnel</i></p> <p>http://www.cpsc.gov/PageFiles/121994/coguide.pdf</p>	2000	Section 7
<p>U.S. Department of Housing and Urban Development</p> <p><i>Durability by Design – A Guide for Residential Builders and Designers</i></p> <p>Chapter 3, Ground and Surface Water Chapter 4, Rain and Water Vapor http://www.huduser.org/portal/Publications/pdf/durability_by_design.pdf</p>	2002	Section 9
<p>U.S. Environmental Protection Agency</p> <p>A Citizen's Guide to Radon http://www.epa.gov/radon/pdfs/citizensguide.pdf</p>	2012	Section 3

Annex H | ANSI/ASPS/ICC 15 Energy Efficiency Compliance Information for Residential Swimming Pools (Informative)

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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.



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/ft³) = _____

2. §5.2.1: Calculated maximum filtration flow rate

(Pool volume ÷ 360 or 36gpm whichever is larger)

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.)

4. Calculated maximum flow rate

(item 2 or item 3, whichever is larger.)

5. §5.5.1: Pipe sizing:

a. Minimum suction pipe diameter

(Enter the smallest pipe size from Table 1 with a 6 fps flow capacity the same or more than item 4.)

b. Minimum suction branch pipe diameter

(Calculate: Item 4. _____ (gpm) ÷ Branch Pipes _____ (quantity) = branch flow rate _____ (gpm). Enter the smallest pipe size from Table 1 with a 6 fps flow capacity the same or more than the calculated suction branch flow rate.)

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.)

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.)

6. §5.4.1: Filter type and size:

a. Filter type: (Cartridge, DE, Sand)

b. Minimum filter area

(Calculate: item 4. _____ (gpm) ÷ filter factor _____)
Filter factors: Cartridge=0.375, Sand=15, Diatomaceous Earth=2

7. §5.4.2: Backwash valve: ___ Yes, ___ No?

(When using a backwash valve, enter result of item 5c or 2 inches whichever is larger)

Table 1

Pipe Size:	1.5"	2"	2.5"	3"	3.5"	4"	6"	8"
Nominal GPM @ 8 fps	38	63	90	138	185	238	374	540
Nominal GPM @ 8 fpe	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

b. Pump flow

(§5.3.2.1, 5.3.2.2: Applicable Curve A or C gpm flow listed in database)

1. _____ gallons _____

2. _____ gpm _____

3. _____ gpm _____

4. _____ gpm _____

5a. _____ inches _____

5b. _____ inches _____

5c. _____ inches _____

5d. _____ inches _____

6a. _____ _____

6b. _____ sq. ft. _____

7. _____ inches _____

8a. _____ _____

8b. _____ gpm _____

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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: gas/oil fired heater efficiency at least 78%, heat pump COP at least 4.0	
Pool systems	5.1.1	Pool filter pump listed in database	
	5.3.1	Pool filter pump with total horsepower 1.0 or more is multi-speed	
	5.3.3	Multi-speed pump controller programmed to default to the filtration flow rate when no auxiliary pool loads are operating within 24 hours and programmed 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.	

Annex I | Determining Ventilation Requirements (Informative)

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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*.

- I.1 Determine the ventilation requirements as outlined in the following section.
 - 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 Buildings* (ASHRAE 62.2-2013), 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 formula⁸:

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

- 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:
 - I.1.2.1 Each kitchen shall have a demand-controlled⁹ 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).
 - I.1.2.2 Measure the flow rate of any existing kitchen and bath fan(s) that exhaust to outdoors.
 - I.1.2.3 For each kitchen and bath, determine the shortfall by subtracting the measured flow from the required flow rate.
- 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.

⁸ The ASHRAE 62.2-2013 Standard also includes a table; use of the table is accepted, but may lead to higher ventilation requirements.

⁹ ASHRAE 62.2-2013 refers to demand-control as “designed to be operated as needed by the occupant”.

- I.1.3.1 *Alternate*: For previously occupied buildings, the alternative compliance path specified in *ASHRAE 62.2-2013: Appendix A – Existing Buildings*, 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:
- I.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 shortfall¹⁰. 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.
- I.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*.
- I.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 $40 \div 4 = 10$ CFM. Thus 10 CFM would be added to the whole-building ventilation rate, Q_{tot} .
- I.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.

I.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.¹¹

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

Where:

Q_{inf} = Infiltration credit in CFM

Q_{50} = blower door measurement¹²

S = Story factor

¹⁰To use this reduction, the AHJ must consider windows an acceptable ventilation method.

¹¹This 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.

¹² BPI allows the use of a single-point blower door test to determine this value, provided the local AHJ permits the single-point test.

wsf = weather and shielding factor for nearest weather station from *ASHRAE 62.2-2013: Appendix B*

13.4.1	Number of Stories	13.4.2	Story Factor (S)
13.4.3	1	13.4.4	1
13.4.5	1.5	13.4.6	1.18
13.4.7	2	13.4.8	1.32
13.4.9	2.5	13.4.10	1.44
13.4.11	3	13.4.12	1.55

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

Where:

Q_{fan} = required mechanical ventilation rate, CFM¹³

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

I.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:

I.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 system¹⁴.

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.

¹³ Per ANSI/ASHRAE 62.2-2013 Draft Addendum B: If QFAN is less than 15 CFM, no additional whole house ventilation is needed.

¹⁴ 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 I.1.3.1.

- I.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 *ASHRAE 62.2-2013*, Section 4.5.2.
 - I.2.3 The system shall have a readily accessible and appropriately labeled override switch that allows homeowner/occupants to suspend normal system operation.
 - I.2.4 Ventilation products must be tested and certified for airflow and sound level in compliance with ANSI/ASHRAE Standard 51/AMCA 210 ANSI/AMCA Standard 210-07 | ANSI/ASHRAE 51-07: 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.)
 - I.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.
 - I.2.6 Newly installed local exhaust ventilation systems that are not run continuously shall have a sound rating of 3.0 sones or less.
Exceptions: remotely mounted fans or fans with a maximum rating of at least 400 CFM have no sound rating requirement.
- I.3 Ventilation system testing for airflow shall be recommended after installation.
- 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.)
 - I.3.2 Verify that each newly installed, upgraded or modified local exhaust fan provides the CFM airflow required as determined in Section I.1.3.

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

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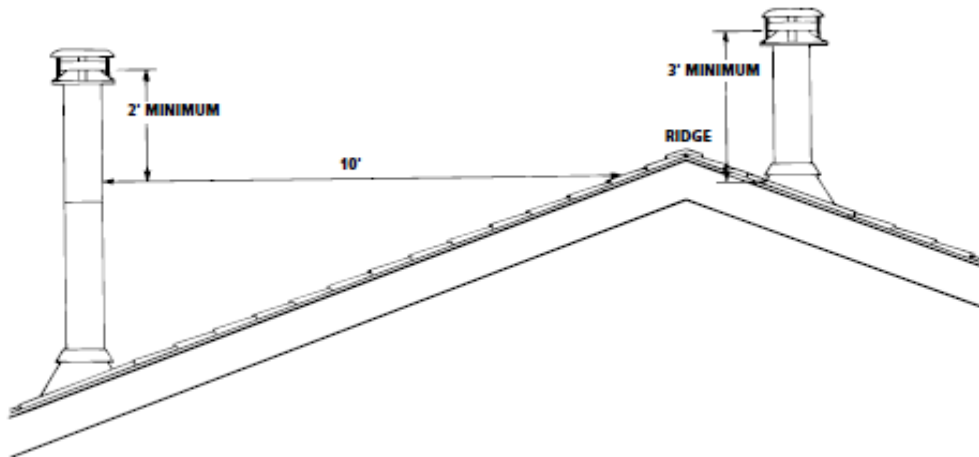
Per Section 7.10.2 of this standard, the auditor may opt to conduct the following visual inspection of the appliance and the venting system for indicators that a recommendation should be given to the homeowner/occupant to call in a trained hearth professional with either National Fireplace Institute (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:

- 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*.¹⁵
- 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.
- J.3. Appliances shall be inspected for compliance with manufacturer's listed application.
- J.4. If so equipped, the system shall be unplugged from its power source during the inspection.
- J.5. Inspect the venting system for proper vent type and horizontal pitch.
- J.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.

¹⁵NFPA 211 defines certain types of installations but does not necessarily approve installation types.

- J.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.
- J.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)

- J.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.
- J.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.
- J.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.

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- J.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:
 - J.12.a Excessive build up of ash deposits
 - J.12.b Excessive build-up of creosote within any portion of the venting, combustion motor, heat exchanger or firebox evident through a visual inspection
 - J.12.c Appliances installed on carpets, wood floors or other combustible materials
 - J.12.d Inadequate clearance to combustible materials
 - J.12.e Signs of structural failure, such as cracks or broken welds, of any components
 - J.12.f Evidence of blockage, restriction, leakage, corrosion, flame roll-out, and other deficiencies that could cause an unsafe condition
 - J.12.i Any venting conditions that do not comply with the manufacturer's recommendations or *NFPA 211*
- J.13 Project documentation shall indicate any conditions deemed to be unsafe.
- J.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.