Results of Electronic Ballot of RESNET Board of Directors on Adopting of the Joint RESNET/Building Performance Institute Comprehensive Home Energy Audit Standard

July 22, 2009

The following are the results of the electronic ballot of the board on adopting Joint RESNET/BPI Comprehensve Energy Audit Standard Standard:

Shall the RESNET Board of Directors adopt the June 26, 2009 version of the Comprehensive Energy Audit Standard that was recommended by the joint RESNET/BPI Comprehensive Home Energy Audit Standard Committee (Attachments A & B)?

Yes (15)	No (1)	Abstain (1)	Not Voting (4)
Steve Byers	Erin Wiggnis	David Wilson	Ben Adams
Dennis Creech			Tom Hamilton
Richard Faesy			Bruce Harley
Philip Fairey			Greg Nahn
Andy Gordon			
David Goldstein			
Michael Holtz			
Mark Jansen			
C.T. Loyd			
Lee O'Neal			
Kelly Parker			
Bill Prindle			
Robert Scott			
Daran Wastchak			
Barb Yankie			

The Comprehensive Energy Audit Standard was adopted by the board.

Attachment A

MEMO

To: BPI & RESNET Board of Directors

From: Laverne Dalgleish & Philip Fairey, Co-Chairs CHEA Standard Committee

Re: Recommendation of Adoption of BPI/RESNET Comprehensive Energy Audit (CHEA) Standard

Date: June 29, 2009

For the past three years, BPI and RESNET have worked collaboratively to develop a Comprehensive Home Energy Audit (CHEA) Standard. The first draft standard was approved by the technical committees and boards of directors of both organizations before going through a public review and comment process.

A joint standard review committee was appointed by the two organizations to consider the public comments, decide on responses, document the results of the deliberation, and develop a final draft CHEA standard for the respective Boards to consider. Members of the joint committee are:

BPI	RESNET
Laverne Dalgleish (Co-chair)	Philip Fairey (Co-chair)
Dave Abrey	Bruce Harley
Jim Fitzgerald	Michael Holtz
John Krigger	Mark Jansen

The BPI and RESNET representatives first considered the comments separately and made recommendations for appropriate responses to public comments and modifications to the standard. In June, the representatives met jointly and came to a consensus on resolution of the public comments (proceedings of the joint committee are attached).

Attached is the final document that the BPI/RESNET Joint CHEA Standard Committee recommends that the BPI and RESNET Boards of Directors adopt.

With this recommendation, the BPI/RESNET Joint CHEA Standard Committee has fulfilled the mandate established by the two Boards. In developing this recommendation, the committee followed the direction given by the two boards and has produced a standard in accordance with the approved title and scope adopted by the two boards.

We would like to recognize the hard work dedicated to producing this standard by many people including Jim Fitzgerald, Bruce Harley, the BPI and RESNET technical committees and the BPI/RESNET Joint CHEA Standard Committee.

Attachment B

Standard for Conducting a Comprehensive Home Energy Audit

FIRST EDITION..... June 2009

BPI/RESNET Board of Standards

Laverne Dalgleish (Co-chair) ..... **Building Professionals Consortium**
Philip Fairey (Co-chair) ..... **Florida Solar Energy Center**
Dave Abrey ..... **GreenHomes America**
Jim Fitzgerald ..... **Conservation Services Group**
Bruce Harley ..... **Conservation Services Group**
Michael Holtz ..... **Architectural Energy**
Mark Jansen ..... **Energy Efficient Homes Midwest**
John Krigger ..... **Saturn Resource Management**

Foreword

The Standard for Conducting a Comprehensive Home Energy Audit describes the requirements for conducting a comprehensive home performance audit. It specifies how to conduct an energy audit, test the home, and prepare a work scope (including specifications for post-work testing).

The selection of measures by the customer and the installation of measures by the contractor(s) are beyond the scope of the standard. The standard is intended to be used in support of building performance programs, although specific program requirements are not part of this document.

The Standard is based largely on existing national standards and draws on documents from the Building Performance Institute (BPI) and the Residential Energy Services Network (RESNET). The two organizations set out to develop a standard that describes an energy audit as performed by an individual qualified as both a BPI Building Analyst and a RESNET Rater. A person certified as a Home Performance Auditor (HPA) is qualified to operate in both capacities.

Technical representatives of BPI and RESNET met and reviewed the organizations' requirements for Building Analyst and Rater, and determined that the requirements for both positions substantially overlapped, with relatively small categories of skills and knowledge specific to one or the other. Combining the contents of the two organizations' documents provided the basis for a single standard encompassing the requirements of both organizations. Content covered in detail in the RESNET Mortgage Industry National Home Rating Systems Standards is included by reference and not duplicated here.

The content of the Standard was updated from earlier versions of the Building Analyst (BA) standard where subject matter was within the scope of a current national standard or published research. Notably, the ventilation requirements and specifications for combustion appliance testing include changes from earlier versions of the BA standard. Explicit steps are included here to reduce misrepresentation.

In this Standard, other standards and research results are generally referenced rather than paraphrased. The Standard must be used in conjunction with these other referenced standards, as outlined in Section 2, and with all appropriate codes.

This Standard is not structured as a handbook or field guide but instead is a reference tool that may provide the basis for handbooks and training materials. It does not include instructional charts, graphics, or background information.

Table of Contents

1. Scope

1.1. This standard provides the requirements and sets forth the test methods for conducting a comprehensive home energy audit.

1.2. This standard includes requirements for analyzing the home, testing the home, rating the home, and developing a scope or work for the energy efficiency of the home.

1.3. This standard is applicable to low-rise residential buildings, both single- and multi-family and to both new and existing homes.

1.4. This standard does not specify requirements for installation of energy efficiency measures included in the work scope nor for confirmation of proper installation.

1.5. Compliance with this standard may require the use of tools and equipment and does not purport to cover all the health and safety issues regarding the use of any tools and equipment. The user shall consult the manufacturer's instructions or other standards on proper use.

1.6. This standard is not intended to supersede or replace any applicable international, national, state, or local code. This standard shall be implemented in a manner consistent with all applicable codes as interpreted by the authority having jurisdiction.

2. References

The documents listed below are referenced in the text of this standard. There are two types of references described below.

2.1. The Home Performance Auditor (HPA) is required to utilize these standards, as applicable, in whole or in part, in order to carry out the energy audits.

Documents Published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)
1791 Tulie Circle N.E., Atlanta, GA 30329 USA;
Telephone: (800) 527-4723; Fax: (404) 321-5478; www.ashrae.org

***ASHRAE 62.2-2007, including Addendum E: Appendix on Existing Buildings,* Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings**

ASHRAE Standard 119-1998 (RA-2004)

Documents Published by the Canadian General Standards Board (CGSB)
Place du Portage, III, 6B1Gatineau, Quebec, K1A 1G6 Canada
Telephone: (819) 956-0425; Fax: (819) 956-5740; www.pwgsc.gc.ca/cgsb

CAN/CGSB 51.71-2005 Depressurization Test

Documents Published by the International Code Council (ICC)
500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001-2070
Telephone: (888) 422-7233; Fax: (202) 783-2348; www.iccsafe.org

2009 International Energy Conservation Code®

Documents Published by the National Fire Protection Association (NFPA)
1 Batterymarch Park, Quincy, MA 30169-7471 USA
Telephone: (617) 770-3000; Fax: (617) 770-0700; www.nfpa.org
NFPA 54-2006, ANSI Z223.1-2006 National Fuel Gas Code

Documents Published by the Residential Energy Services Network (RESNET)
P.O. Box 4561, Oceanside, CA 92052-4561 USA
Telephone: (760) 806-3448; Fax: (760) 806-9449; www.resnet.us
2006 Mortgage Industry National Home Energy Rating Systems Standards

3. Terms and definitions

air-free carbon monoxide: A measurement of carbon monoxide (CO) in an air sample or flue gas that estimates the amount of excess air (oxygen, O_2) in the sample. The measurement incorporates an adjustment to the as-measured CO ppm (parts per million) value to simulate oxygen-free conditions in the sample. (See "as-measured carbon monoxide.")

ANSI: American National Standards Institute.

as-measured carbon monoxide: A direct measurement of carbon monoxide CO in a sample of air or flue gas, usually measured in ppm (parts per million) units. (See "air-free carbon monoxide.")

atmospheric-vented: An appliance using a natural draft venting system.

atmospheric pressure: The weight of air and its contained water vapor on the surface of the earth; at sea level, this pressure is 14.7 pounds per square inch.

backdraft: Sustained downdraft during burner operation.

boiler: A space heating appliance that heats water with hot combustion gases that pass through a heat exchanger.

base load: An estimate of fuel consumption that does not include cooling or heating fuel consumption.

CAZ: See "Combustion appliance zone"

carbon monoxide (CO): An odorless, colorless gas that can cause illness or death.

carbon monoxide emissions: Carbon monoxide (CO) resulting from combustion as measured in ppm (parts per million. The measurement of CO emissions in flue gas requires a sample to be taken before dilution air enters the venting system. (See "air-free carbon monoxide" and "as-measured carbon monoxide.")

combustion appliance zone: A contiguous air volume within a building that contains a combustion appliance; the zone may include, but is not limited to, a mechanical closet, mechanical room, or the main body of a house, as applicable.

comprehensive home energy audit: A comprehensive evaluation of a home to determine its existing energy performance through visual inspection, measurement, performance testing,

and energy simulation and analysis. The evaluation identifies improvement measures and repairs to the home.

conditioned space: Any directly conditioned space or indirectly conditioned space, as defined in this standard.

dilution air: Air that enters a draft diverter or draft regulator from the room in which the appliance is located.

directly conditioned space: A space within a building that is provided with heating and/or cooling using equipment and distribution systems are capable of maintaining 65°F or higher at heating design conditions and 80°F or lower at cooling design conditions, or a space that communicates directly with such a space.

direct-vent appliance: A combustion appliance for which all combustion gases are vented to the outdoors through an exhaust vent pipe and all combustion supply air is vented to the combustion chamber from the outdoors through a separate, dedicated supply-air vent.

downdraft: Air flow from a chimney or venting system into an enclosed building space.

draft: A pressure difference that causes combustion gases or air to move through a vent connector, flue, chimney, or combustion chamber.

draft diverter: A nonadjustable device built into an appliance or a part of a vent connector that is intended to (1) permit the escape of flue gases in the event of a blockage or backdraft; (2) prevent a downdraft of outdoor air from entering the combustion chamber of an appliance; (3) reduce the effect of the chimney's stack action; and (4) lower the dew point temperature of the flue gas by the infusion of room air.

draft regulator: A self-regulating damper attached to a chimney or vent connector for the purpose of controlling draft: A draft regulator can reduce draft; it cannot increase draft.

excess air: Air supplied to a burner in excess of the amount needed for complete combustion.

fan-assisted combustion: A combustion appliance with an integral fan that draws combustion supply air through the combustion chamber.

flame rollout: a condition in which burner flames discharge from the cabinet of a combustion appliance.

furnace: A space heating appliance that heats indoor air with hot combustion gases that pass through a heat exchanger.

HVAC: Heating, Ventilation and Air Conditioning.

IECC: International Energy Conservation Code.

inches of water column (IWC): A unit of pressure difference; 1 IWC = 250 Pascals (see "Pascal.")

indirectly conditioned space: A space within a building that is not directly conditioned, but meets one of the following criteria: (1) the area-weighted U-factor of the boundary between it and directly conditioned space exceeds that of the boundary between it and the outdoors or the ground, where U = sum (UA)/sum(A); (2) air to or from directly conditioned spaces is mechanically transferred at a rate exceeding 3 air changes per hour; or (c) any unvented basement or crawl space that contains heating equipment or distribution systems, and for which 50% or more of the floor separating it from conditioned space has no thermal insulation installed.

induced combustion: See "fan-assisted combustion."

isolated combustion appliance zone: A combustion appliance zone that is not a part of, nor directly connected to, habitable space. It is either outdoors, or is a mechanical room or attached garage that is supplied with outdoor combustion air and separated from habitable space, and which complies with the criteria in Section B.3.2 of this standard.

natural draft venting system: A venting system that relies on buoyancy to move combustion gases to the outdoors.

NIOSH: National Institute for Occupational Safety and Health.

OSHA: Occupational Safety and Health Administration.

Pascal (Pa): The metric unit of pressure equaling 1 Newton per square meter, or 0.004 inch W.G..

power burner: A burner for which air is supplied at a pressure greater than atmospheric pressure; includes most oil-fired burners and gas burners used as replacements for oil burners.

power-vented: A appliance that operates with positive static pressure in the vent, and is constructed and installed with a fan or blower to push all the products of combustion directly to the outdoors through independent sealed vents connected directly to the appliance.

predicted depressurization: Calculated house depressurization after improvements, accounting for estimated change in house tightness and exhaust fan flow.

spillage, spill: Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.

U-factor: Coefficient of thermal transmittance (expressed as Btu/h-ft2-oF (W/m2-oC)) of a building envelope component or system, including indoor and outdoor air film transmission coefficients.

unconditioned space: Any enclosed space within a building that is neither directly nor indirectly conditioned.

vent connector: The pipe that connects a combustion appliance to a vent or chimney.

venting system: A passageway or passageways from a combustion appliance to the outdoors through which combustion gases pass.

work scope: A set of written recommendations, including specifications detailing repairs and improvements to be made to a home; a work scope may include pre- and post-work performance testing and acceptance criteria.

4. General requirements

4.1. **Personnel requirements**. The home performance auditor shall be certified as demonstrating the knowledge and skills required to complete all tasks in this standard (see Annex D).

4.2. **Worker safety requirements**. The home performance auditor shall comply with all applicable OSHA regulations.

4.3. **Customer interview**. The home performance auditor shall conduct an initial interview with the owner or tenant by telephone or in person and shall, at a minimum, collect the information outlined in Annex A.1.

4.4. **Utility bill review and analysis**. If fuel consumption history is available, the home performance auditor shall estimate annual average cooling, heating, and base load components of fossil and electricity energy use.

5. On-site inspection and data collection requirements

5.1. **Initial Survey**. In a previously or presently occupied home, the home performance auditor shall conduct a survey inspection with the customer to elicit additional issues or concerns. The inspection and data collection shall follow the requirements of Annex A.

5.2. **Data collection for home energy rating.** The home performance auditor shall inspect the home and collect the information required to conduct a home energy rating in accordance with Chapter 3 and Appendix A of the RESNET Mortgage Industry National Home Energy Rating Systems Standards.

5.3. **Building enclosure air-tightness test.** Conduct an air-tightness test.

5.3.1. Air-tightness testing shall be conducted in accordance with ASHRAE Standard 119 RA-2004, Section 5.1, except that the building may be tested at a single pressure differential of 50 Pa. The building shall be prepared for testing in accordance with the requirements of the RESNET Mortgage Industry National Home Energy Rating System Standards, Appendix A, in the section titled “Rated Feature – Blower door test”.

5.3.1.1. During the initial pressurization or depressurization test, the home performance auditor shall determine major leakage areas in the living area. The auditor shall use neutral buoyancy smoke, infrared camera, or other such device to aid in identifying air leak sites and misalignments between the air pressure boundary and the intended thermal boundary. When possible, the customer should accompany the home performance auditor.

5.3.1.2. Record presence of observed air leaks including but not limited to: window trim, baseboards, upper trim, cabinets, dropped soffits, pocket doors, recessed lighting, duct chases/plenums, band joists; transitions between porch and roof exterior walls, fireplaces,

cantilevered floors; in walls or ceilings between the conditioned space and an attached garage.

5.3.2. Exception: Air tightness testing may be omitted, provided that it is included as a requirement in the work scope whenever air sealing, closed cavity insulation, or duct sealing work is proposed in accordance with Section C.4.2 of this standard.

5.4. **Assessment of mechanical systems**

5.4.1. **Heating and cooling systems**

a. Review maintenance record; record frequency of tune-ups and repairs, as available.
b. Check the condensate lines for signs of leaks; record results. Notice if condensate line drains to proper location.
d. Record interference with outdoor unit airflow attributable to proximity of outdoor coil to deck, cantilever, or plantings or heat transfer inefficiencies due to clogging of outdoor coil with debris.

5.4.2. **Air handlers and coils**

a. Record condition of blower and coil, if accessible, and any need for cleaning.
b. Inspect air filter(s) and check with customer on frequency of change-outs.
c. Record presence of secondary overflow pans; verify presence of condensate drain line or float disconnect switch.

5.4.3. **Ductwork**

a. Inspect duct system to extent possible; record insulation R-values, visually detected duct leaks, disconnects, collapsed or kinked ducts, signs of moisture presence and damage, and other sub-standard conditions.
b. Record presence of permanently installed humidifier, along with evidence or reports of its operation, clogging/scaling, or evidence of mold growth in unit.

5.4.3.1. **Duct leakage test.** Conduct a duct leakage test. Duct system leakage shall be measured in accordance with the RESNET Residential Mortgage Industry National Home Energy Rating System Standards.

Exception 1: in an existing home, a duct test need not be conducted when a duct system meets all of the following conditions:

i. The system air handler and a minimum of 75% of the surface area of connecting ductwork are located inside conditioned space.
ii. A “pressure pan” test is conducted as follows: During a blower door pressurization or depressurization test, the blower door is set to maintain a pressure difference of 50 Pa between inside and outside. One at a time, each supply or return register in the system is covered with a “pressure pan” device or airtight membrane, that is sealed or gasketed to the surrounding surface. For each register, the pressure

difference between the inside of the building and the space containing the register is measured and recorded.

iii. When measured in this manner, the largest recorded pressure difference at any one register is 3 Pa or less, and the average of the recorded pressure differences at all supply and return registers in the system is 1 Pa or less.

Exception 2: Duct leakage testing may be omitted, provided that it is included as a requirement in the work scope whenever work is proposed in accordance with Section C.5.2 of this standard.

5.4.4. **Boiler system, hot water pipes, steam pipes, and baseboard radiators**

a. Record insulation levels on hot water and steam distribution pipes and note opportunities for pipe insulation, particularly on long pipe runs.
b. Record condition of hydronic baseboards or convectors.
c. Record signs of water leakage from boiler vessel or piping.

5.4.5. **Water heater**

a. Record approximate age and condition of water heater(s).
b. Record temperature setting on water heater(s).
c. Record signs of leakage from water heater(s) .
d. Record opportunities for efficiency improvement to water heater(s) and hot water pipes (presence or absence of insulation, thermosiphon loop, and feasibility of retrofitting insulation on tank and/or pipes).

5.4.6. **Mechanical ventilation**

Record presence of local exhaust ventilation system in bathrooms and kitchen.

5.4.7. **Combustion appliance, combustion appliance zone (CAZ), and living space tests and inspections**

5.4.7.1. **General combustion appliance inspections**

Record presence of flammable or explosive materials stored near any combustion source; if found, request immediate relocation of materials to a safer place.

5.4.7.2. **Water heater inspection**

a. Record evidence of backdraft/flame rollout.
b. Verify that pressure relief valve is present and not obstructed.

5.4.7.3. **Heating system inspection**

a. Record evidence of backdraft/flame rollout.
b. If boiler is present, verify that pressure relief valve is present and not obstructed.

5.4.7.4. **Combustion appliance testing**

Combustion appliance testing shall be conducted in the home per Annex B.

6. Software and analysis requirements

6.1. **Software.** The home performance auditor shall conduct a Home Energy Rating using software accredited by RESNET for the purpose of conducting comprehensive home energy audits.

6.2. **Billing history**

6.2.1. When billing history for a year or more is available for any fuel, the predicted savings for all proposed measures relating to end-uses using that fuel shall not be greater than 100 percent of all the annual historical consumption of that fuel. When predicted savings are greater than 65 percent of annual consumption of a fuel, the work scope shall be accompanied by the following notice: "This proposed package of improvements includes an estimate of fuel savings greater than 65 percent for the following fuel(s): _<*specify: fuel type(s)*>_ . Savings of more than 65 percent of historical consumption is exceptional and would typically indicate a comprehensive set of improvements or a solution to an unusual and specific energy problem."

6.2.2. Predicted savings greater than 100 percent of annual electric consumption may be allowed when on-site power generation is included in the estimate. When predicted savings are greater than 100 percent of electric consumption, the work scope shall be accompanied by the following notice: "This proposed package of improvements includes on-site power generation in excess of predicted electric consumption. Predicted electric consumption is based on standard operating conditions; actual results may vary due to variations in customer lifestyle and operating conditions."

6.3. **Savings Analysis.** The following exceptions to the operating conditions specified in Chapter 3 of the RESNET Mortgage Industry National Home Energy Rating Systems (HERS) Standards may be used for the purpose of calculating heating and cooling savings estimates for measures in the work scope, but not for the purpose of calculating the HERS index:

a. Actual thermostat set points observed by the home performance auditor may be used, but automated setback schedules shall be limited to the schedule specified in the RESNET Mortgage Industry National Home Energy Rating Systems Standards, Section 303.5.1.2.
b. Electrical or fossil fuel end-uses that are not covered in the list of Minimum Rated Features may be included in the analysis in accordance with the RESNET Mortgage Industry National Home Energy Rating Systems Standards, Paragraph 303.7.1.5.n.

7. Requirements for development of work scope

7.1. **Development of work scope**: The home performance auditor shall develop a work scope for each building, specifying a set of home performance improvements. The home performance auditor shall review and include, at a minimum, all applicable improvements as required by Annex C.

8. Customer review of HPA findings and documentation

8.1. The home performance auditor shall present the customer with an overview of the inspection findings as well as the recommended work scope.

8.2. **Documentation requirement.** A home performance auditor shall provide the customer with a summary report on the home performance audit in written or electronic form. The following elements, at a minimum, shall be included in the summary report:

a. Auditor name, contact information, and certification number
b. Address, city, and state of analyzed home
c. Date of audit
d. Description of existing conditions
e. Copy of the work scope in accordance with Section 7 of this standard
f. Copy of rating report in accordance with Section 303.3 of the RESNET Mortgage Industry National Home Energy Rating System Standards.

Annex A (Normative): Customer Interview and Survey inspection

A.1. The home performance auditor shall conduct a customer interview to obtain the following information, as available:

a. Energy consumption history
b. Age of home
c. Number of occupants
d. General condition; recent and planned remodeling or renovations
e. Use of basement space, if applicable
f. Thermostat settings and schedules
g. Comfort complaints such as hot or cold rooms, cold drafts
h. Building maintenance complaints such as condensation, plumbing or roof leaks, ice dams, or foundation moisture
i. Indoor air quality complaints; occupant allergies or asthma
j. High utility bills; other questions or complaints
k. Use of swimming pool when present, including typical use dates, daily hours of pump operation, pool heating, and ventilation strategy (if indoors)
l. Number of solid fuel appliances, unvented fireplaces, and/or space heaters, and their use

A.1. The home performance auditor shall conduct an inspection of the home and record any of the following data, as applicable:

a. **Appliances.** Record presence and quantity, approximate age, type, and condition of the following:
    - Refrigerator(s) and freezers, including model number(s) and year(s) of manufacture; if prior to 1993, rated annual consumption if available.
    - Room air conditioner(s), whether currently or seasonally installed, including model numbers and EER ratings
b. Opportunities to upgrade lighting to ENERGY STAR compact fluorescent (CFL) screw-base lamps or fixtures; estimate of daily operation from customer for any lighting recommended for replacement
c. Number, location, and operability of carbon monoxide alarms in living space

A.2. Building envelope inspection. Record major features of home, including the following:

a. General configuration of home including age and location of known or identifiable additions or renovations.
b. Opportunities for renewable technology (e.g., s)
c. Floor plan, with orientation and exterior dimensions, noting major features and geometry
d. Evidence of high moisture levels in living space, including evidence of moisture deposition or damage
e. Issues with shading or solar exposure that may affect comfort
f. Surface grades that may direct water to basement, slab, or crawl space

A.3. Attic visual inspection. Record attic conditions, including:

a. Presence of openings in wall top plates, electrical, plumbing, and duct chases; open areas around flues and chimneys and recessed light housings; open framing cavities; dropped soffits; and ceilings.
b. Signs of roof moisture damage from roof leaks or condensation

A.4. Basement visual inspection. Record basement or crawl space conditions, including:

a. Presence of air leakage openings such as around electrical, plumbing, and duct systems; around flue pipes and chimney and accessible sill plate or band joist areas; and around basement windows or exterior doors
b. Presence of vapor barrier over exposed soil; needed repairs
c. Type and condition of slab floor, if present
d. Signs of moisture deposition or damage on basement floors, walls, and sill plate area and around basement windows and bulkhead door

A.5. Enclosure thermal characteristics. Record enclosure thermal characteristics, including:

a. Thermal boundary of home and thermal bridges that compromise integrity of the boundary

Annex B (Normative): Combustion appliance screening test

B.1 Combustion appliance screening. Combustion appliance testing shall be conducted as part of every comprehensive home energy audit according to these requirements. Modern direct-vent and power-vented equipment shall undergo limited testing; equipment isolated from house pressure effects shall undergo a moderate level of testing; and natural draft equipment that takes combustion and dilution air from inside the home requires more testing. A comprehensive combustion equipment safety analysis is beyond the scope of this document.

B.1.1 Where recommendations are made as part of a home performance audit for a new home, combustion appliance testing shall be conducted upon substantial completion of the home in accordance with this standard.

B.1.2 Any work scope presented to the building owner or occupant shall specify combustion appliance testing as required both before and after completion of work. Testing completed as part of the home performance audit qualifies as required pre-work testing.

B.2 Required combustion appliance tests. The following test procedures are required on all homes as applicable:

a. Notification of suspected gas leaks
b. A carbon monoxide (CO) test on each combustion appliance after 5 minutes of operation
c. An oven test (if oven is present) after 5 minutes of operation
d. A visual venting system inspection
e. A combustion appliance zone (CAZ) test
f. As required, an isolated zone inspection

B.3 Appliance conditions and additional required tests. Specified conditions may apply to the home as-is during the test or to the as-proposed home based on the work scope.

B.3.1 Required tests for direct-vent or power-vented appliances include a visual confirmation that the venting system is connected, that all joints are connected from the appliance to the outdoors, and that the vent is functioning.

B.3.2 Atmospheric-vented appliances in an isolated zone. Important Note: Use of any combustion air from indoors to meet combustion air requirements disqualifies an appliance from this designation. Required tests include the following:

a. Visual inspection of venting system
b. Visual confirmation of decoupling of isolated CAZ from house and spillage test under non-depressurization conditions

B.3.3 Atmospheric-vented appliances. Any atmospheric-vented appliance located within the home that does not meet the requirements in B.3.2 of this standard shall require the following tests:

a. Visual inspection of venting system
b. CAZ depressurization test consistent with CGSB 51.71-2005
c. Spillage test consistent with the draft test in NFPA 54 2006 11.6

B.4 Action levels. The home performance auditor shall include in each recommendation or work scope specific action to be taken, when certain limits are exceeded. These limits include the CAZ depressurization limits shown in Table B.4.1, sustained vent gas spillage greater than 5 minutes, appliance CO levels in excess of those shown in Table B.4.2, CAZ or indoor CO levels in excess of those shown in Table B.4.3, or a suspected gas leak.

B.4.1 Air free measurement of CO, when available, shall take precedence over as-measured.

Table B.4.1 Combustion Zone Depressurization Limits

Appliance type	Depressurization Limit Pascals (IWC)
Direct-vent or power-vented	50 (0.20)
Pellet stoves with exhaust fans and sealed vents	15 (0.06)
Atmospheric vented oil and gas system, oil power burner; fan-assisted or induced-draft gas; solid-fuel–burning appliance other than pellet stoves with exhaust fans and sealed vents	5 (0.02)

Table B.4.2 Appliance CO Limits, Maximum

Appliance Type	As-Measured	Air-Free
Furnace, boiler, water heater, vented space heater other than solid-fuel–burning	100 ppm *	400 ppm
Oven	200 ppm	800 ppm

* Or original equipment per manufacturer's recommended level if specified.

Table B.4.3 Indoor Air CO limits

NIOSH Personal exposure limit (time-weighted average)	8 hours	35 ppm
NIOSH Personal exposure limit (ceiling)	15 minutes	200 ppm

Combustion Appliance Screening Procedure

Combustion Appliance Screening Technician name:_____

Customer Name:_____ **Site ID**_____ **Date**_____

Explain briefly what you will be doing. Current thermostat setting _____

1) With client present, make sure HVAC system is working. Y / N

Quick Check:

2) Set up CO instrument outdoors per manufacturer's instructions.

3) Turn equipment off. Measure indoor CO levels. Note strong gas odor, fuel leaks, visual inspection of venting.

If CO >35ppm ventilate home; if strong gas odor - get people out and call from outside home for assistance.

4) Determine location(s) of combustion equipment:

(a) main body of house (incl. basement); (b) isolated zone: (e.g., closet, garage, crawlspace, attic)

5) If isolated zone (mechanical closet), check for combustion air, openings to house and duct leaks in zone. (recommend sealing duct and house leaks, and adding combustion air.)

6) If natural draft combustion equipment is in main body of house or basement, test CAZ pressure change:

(a) Close all exterior windows, doors, & fireplace dampers. Close all interior doors. Measure pressure in CAZ with reference to (WRT) outside. Compare to depressurization limits

(b) Turn on HVAC fan, dryer, kitchen fan and any exhaust fans 150 CFM and larger; whole house cooling fans remain off.

(c) Measure new pressure in CAZ WRT outside; open door to CAZ, repeat measurement. Compare with depressurization limits.

(d) Alternative to CAZ test / CAZ over limit: provide spill switch or alarm on remaining natural draft appliances, including water heater.

7) Turn off all fans. Turn on water heater, furnace, boiler, space heater; test spillage and CO at 5 minutes.

7a) For power vented/direct vented equipment, measure CO at outlet if accessible. Confirm exhaust to outside.

If hot weather prevents furnace/boiler from firing, note in comments and provide CO alarm and spill alarm.

8) Gas oven: if no kitchen fan present, test after 5 minutes or steady state. Optional if fan and CO alarm are present or recommended.

8a) Note if unvented gas or kerosene heater(s) are primary heat source for residence, as this is outside of listing and ICC codes.

9) Report to supervisor and recommend service if gas leak, vent problems or high CO measured. Refer to limits in section B.4. Recommend actions to upgrade appliance, reduce depressurization, if CAZ test is beyond

limits. If CO is over limit and spillage occurs, turn off appliance and require signed disclosure.

Annex C (Normative): Work scope development

C.1. Work scope requirements

C.1.1. **General.** The requirements for developing the work scope include:

a. A list of all proposed repairs and home performance improvements
b. Priority listing of proposed efficiency measures as defined by software analysis, sponsored program requirements, homeowner needs, or indicators of cost-effectiveness screening based on analysis of costs and savings.
c. Estimate of energy savings and an indication of ~~return on investment~~ cost effectiveness.

C.2. Pre-existing and projected conditions.

C.2.1. Combustion Testing. When conditions that exceed the action levels as specified in section B.4 of this standard have been documented during the home performance audit, or these conditions are likely to be achieved as a consequence of the installation of recommended measures, the work scope shall include measures to address such conditions.

C.2.2. Building conditions outside the scope of a Comprehensive Home Energy Audit. When building conditions are questionable with regards to moisture, safety, or building codes, the Home Performance Auditor shall recommend that the customer engage the services of a professional with certification or expertise in that area to evaluate risks and make recommendations. Such recommendations shall include (as applicable), but not be limited to the following:

C.2.2.1. **Leaks**. The work scope shall state that work will not commence before repair of all known or observed roof and plumbing leaks has been accomplished. ,

C.2.2.2. **Crawl space drainage.** Any work scope for a building with a crawl space foundation(s) with a history of standing water or located in a flood zone shall recommend mitigation of this problem or potential problem.

C.2.2.3. **Electrical components.** The work scope shall:

a. Recommend an inspection by a licensed electrician or local inspector when potential electrical hazards are found in an area of the home affected by proposed work. The local authority with jurisdiction shall make any determination of hazard and interpret the electrical code.
b. Specify that insulation clearances are to be maintained or fixtures upgraded where there is evidence of recessed lights that are not rated for insulation contact, mounted in a surface where insulation may be applied.
c. Explicitly prohibit the installation of new insulation in hollow spaces of walls, ceilings, or attics where insulation may be in contact with knob and tube wiring per NFPA 70, Section 394.12, and require clearances

between insulation and wiring to be maintained in affected areas during installation

Exceptions:

1. When the work scope calls for all wiring in affected areas to be upgraded.
2. When the authority having jurisdiction allows exceptions to NFPA 70 Section 394.12, under specific conditions, the work scope shall adhere to those conditions as applicable.

C.2.2.4. A recommendation for radon testing and mitigation systems for dwellings located in EPA radon risk Zone 1 (see www.epa.gov/radon/zonemap.html) shall be made in the work scope or other customer communication.

C.3. Moisture control

C.3.1. Window and door flashing

C.3.1.1. Any work scope that includes installation or replacement of windows or doors shall specify sealant, flashing, drainage, and installation details per ASTM E-2112-07. The work scope shall specify installation, wherever possible, of sill flashing with end and back dams that drain to the exterior cladding surface under all new windows and doors as well as water-shedding details on the exterior and air-tight foam sealant between new and old frames in replacement windows.

C.3.2. Exterior insulation or cladding

C.3.2.1. Any work scope that includes exterior rigid insulation or exterior cladding installation shall require the following:

a. Continuous drainage plane or weather-resistant barrier (WRB) behind cladding: may include taped and sealed or flashed rigid insulation, sealed house wrap, or other WRB that is installed shingle-style.
b. Window and door flashings at head, jamb, and sill, integrated with WRB to drain to exterior.
c. Flashings at roof-to-wall intersections, including step flashings and kick-out flashing consistent with specific climate zone and annual rainfall provided in the EEBA Builder's Guides, where the bottom of any wall terminates at an existing roof; siding edge shall be held 1 inch or more above adjacent roof sections.

C.3.3. Crawl space moisture barrier

C.3.3.1. Any work scope for a building with a crawl space foundation(s) shall include the following:

a. Installation of a minimum 0.006-inch-thick polyethylene or 0.004-inch-thick cross-laminated polyethylene ground moisture barrier
b. Overlapping of edges of moisture barrier by a minimum 12 inches and permanent sealing of all seams and penetrations with acrylic adhesive tape or compatible sealant
c. Lapping moisture barrier up the crawl space perimeter walls a minimum 6 inches

d. Sealing and mechanically fastening or adhering moisture barrier edges to a clean wall surface
e. Documentation of clearance limitations, obstructions, or other conditions that may prevent complete coverage

C.4. Enclosure Air leakage

C.4.1. Sealing. The work scope shall include sealing the air leakage areas identified during the site inspections under Section 5.3, A.3, or A.4 of this standard. At a minimum, the work scope shall specify the following:

a. As a high priority, sealing leaks between the garage and adjacent living space
b. As a priority, sealing leaks or adding new air barrier materials to align the air pressure boundary with insulation
c. As a priority, sealing with blocking or sheathing all openings between framing elements that are open to attic, roof, garage, or crawl space

C.4.2. Air-tightness test. The work scope shall specify an air-tightness test to be conducted under the following conditions:

a. Before work commences, whenever the air-tightness test was omitted during the audit.
b. After work is completed when sealing a new dwelling to a specified level or threshold
c. After work is completed when air sealing a building enclosure or installing closed-cavity insulation
d. After work is completed when sealing a duct system with at least 15 percent of the ducts outside conditioned space, when sealing an air handler located outside conditioned space

C.4.2.1. Air-tightness testing shall be conducted in accordance with section 5.3.1 of this standard.

C.5. Ducts

C.5.1. Duct sealing. The work scope shall include the sealing of duct systems and air handlers located in attics, garages, and unconditioned crawl spaces identified during the site inspections under section 5.4.3 of this standard. At a minimum, the work scope shall specify the following:

a. As a high priority, sealing of return duct and air handler leaks in attached garage
b. Relocation of air handler or return ductwork when either is located in a garage or creation of an air-tight enclosure to isolate air handler or return ductwork from the garage.

C.5.2. Duct leakage test. The work scope shall specify that a duct leakage test be conducted under the following conditions:

a. Before work commences, whenever the duct leakage test was omitted during the audit.
b. After completion of work when sealing ducts to a specified level or threshold in a new dwelling

c. After completion of work when sealing a duct system or air handler located outside conditioned space or where significant duct modifications have been completed within conditioned space

C.5.2.1. Duct leakage testing shall be conducted in accordance with section 5.4.3.2 of this standard.

C.5.3. Duct repairs.

C.5.3.1. The work scope shall call for the repair of crushed, poorly fastened, restricted, or poorly supported ducts as well as for any duct system modifications to improve air flow before duct sealing or duct insulation.

C.5.3.2. An air handler air-flow test shall be conducted on air conditioners and heat pumps in accordance with ASHRAE 152-2004, Annex A, using either the "duct-pressurization and flow measurement device" (plenum pressure-matching method) or an "air-handler flow plate device." The air handler air-flow test shall be conducted at the higher of heating or cooling fan speed, under the following conditions:

a. Before and after completion of work, when sealing a duct system or air handler located outside conditioned space is specified in the work scope
b. Where duct modifications within conditioned space are specified in the work scope
c. Note: An air-flow test conducted during the home performance audit shall qualify as a specified "before work" air flow test in the work scope.

C.5.3.3. When the work scope includes duct sealing or duct system modification in a home where returns are centrally located, the work scope shall also include the following provisions:

a. The work scope shall include measures to limit pressure differentials across closed doors during air handler operation to 2.5 Pascals or less, by providing ducts or other air transfer pathways between closed room(s) and the main body of the house containing the return(s).
b. The work scope shall include testing or inspection to confirm that pressure differentials across closed doors are no more than 2.5 Pascals unless return transfer air mechanisms are provided according to the following:
    1. Transfer duct(s) at least equal in cross-section area to the supply duct(s), along with door(s) undercut at least 1 inch and unrestricted, or
    2. Transfer grille(s) that provide 0.5 square inch of grille area for each design CFM of supply air flow, with the door(s) undercut at least 1 inch and unrestricted.

    Note: bathrooms, closets, storage rooms, and laundry rooms are exempt from these requirements, except that all supply air provided to a suite containing these rooms shall be included in testing or calculation of the return air transfer from the suite.

C.5.3.4. When the work scope includes either complete duct replacement combined with attic insulation and sealing, or roof replacement, the work scope shall also include the option to bring the new duct system and air handling equipment inside the conditioned space, or to extend the conditioned space to include the duct system.

C.5.3.5. The work scope shall also include:

a. Insulation of duct system components per the IECC requirement when the work scope includes installation of new duct systems or system components
b. Duct air sealing shall follow any installation or repair
c. Duct insulation, when specified, shall follow any duct air sealing

C.6. Combustion appliances

C.6.1. Combustion appliance testing. The work scope shall include post-work combustion appliance testing according to Annex B of this standard. Post-work tests shall be specified according to the home's proposed condition at completion of work and shall specify acceptance criteria for post-work test results.

C.6.2. Gas leaks. The work scope shall include repair of gas leak(s) detected during the combustion appliance screening (Annex B of this standard), and replacement of any worn, damaged, or aged flex connectors .

C.6.3. Oven CO emission levels. The work scope shall call for repair or replacement of any oven found to be producing carbon monoxide, as follows: When the measured oven CO is above the limits specified in Annex B, Table B.4.2, the work scope shall call for service to reduce CO levels as low as possible, and in no case over 800 ppm air-free. The work scope shall call for installation of one or more CO alarm(s) per (a) above when the measured CO after service remains above 100 ppm as-measured or 400 air-free.

C.6.4. Spillage. The work scope shall specify measures to reduce spillage, when measured in excess of limits specified in the CAZ test/spillage test, by either of the following:

a. Replacement of all affected equipment by new direct-vent or power-vented appliances, or
b. Correction of venting system deficiencies.

C.6.5. CAZ depressurization. When CAZ depressurization is measured in excess of the limits in Table B.4.1, the work scope shall call for one or more of the following, as applicable::

a. Replacement of all affected equipment by new direct-vent or power-vented appliances
b. Taking measures to reduce depressurization to within limits.
c. Provide spill alarm or spill switch on affected appliance(s).

C.6.6. Isolated zones When combustion equipment is already in place or is specified to be installed in an isolated zone, the work scope shall call for the following:

a. Removal of obstructions from existing outside air openings,

b. Provide additional outside air opening area as required to meet NFPA 54 9.3.3., and
c. Seal air leaks in walls, ceiling and/or floors separating the isolated zone from conditioned space, consistent with section B.3.2

C.6.7. Venting system. The work scope shall specify repair or replacement of the venting system(s) and/or equipment when the results of the venting system inspection in Section B.3 show deficiencies that could cause an unsafe condition.

C.7. Mechanical heating, ventilating, and cooling systems

C.7.1. Replacement and repair of heating or cooling equipment.

C.7.1.1. When replacement systems are called for, the work scope shall specify that sizing of replacement systems be conducted in accordance with ACCA Manual J: *Residential Load Calculation*, and *Manual S: Residential Equipment Selection*, using the following criteria:

a. Indoor design temperatures of 75°F and 50 to 55 percent relative humidity (cooling), and 70°F (heating)
b. 99 percent (cooling) and 1 percent (heating) outdoor design temperatures for the home's location or most representative city for which design temperature data are available
c. Calculations that account for any measures specified in the work scope, such as air sealing, duct sealing, window shading, or other load reductions, that reduce heating or cooling loads
d.

C.7.1.2. For HVAC replacement or repair, the work scope shall specify in accordance with ANSI/ACCA 5 QI *HVAC Quality Installation Specification*, as applicable.

C.7.1.3. For steam boiler replacement or repair: note if steam radiators are pitched properly to drain condensate

C.7.2. New vapor-cycle refrigerant-based equipment. Cooling or heat pump replacement (when specified) shall include:

a. Replacement of inside coil with a new, acceptable match to the outside coil as listed in the version of the AHRI *Directory of Certified Product Performance* that is current at the time of the home performance audit, or confirmation of the existing inside coil as an acceptable match per manufacturer's instructions, including presence of TXV (thermal expansion valve) if required
b. Confirmation of acceptable refrigerant charge and air flow per manufacturer's instructions
c. A "clean and tune," including a heat exchanger inspection, when an existing gas furnace is to remain in operation
d. For heat pumps, installation of electric resistance lock-out control that activates when outside temperature exceeds 35F (with exception

during emergency heat and defrost modes), and test to confirm proper sequence of operation.

e. For heat pumps, information provided to customer about indoor thermostat operation to limit electric resistance heating usage after thermostat set-back.

C.7.3. Ventilation system. The work scope shall include recommendations for either installation of continuous mechanical ventilation and local exhaust ventilation, or upgrades to existing equipment, in accordance with Appendix C of ASHRAE 62.2-2007.

Exception: The work scope shall not call for exhaust-only mechanical ventilation if existing or predicted CAZ depressurization is at or exceeds the limits shown in Table B.4.1 of this standard, for appliances that are to remain in place after completion of the work.

Predicted CAZ depressurization resulting from sealing of the building enclosure shall be estimated based on predicted post-work enclosure leakage and expected total post-work exhaust fan flow, per the following equation:

Predicted depressurization (Pa) = 50 x (post-work sum of rated CFM of exhaust appliances/predicted post-work house CFM 50)^1.54, where the rated CFM of exhaust appliances includes all exhaust fans or appliances listed in Annex B of this standard that are expected to be operable after completion of work.

C.8. Unvented combustion appliances. When the home has one or more decorative gas logs, as defined in Section K.1.11 of NFPA 54-2006, or any other unvented combustion appliance other than a gas oven or range, the work scope:

a. Shall not specify enclosure air sealing or duct air sealing. For climate zones 1 through 3 as specified in 2009 IECC, duct sealing outside the air and thermal boundary may be permitted.

b. Shall specify a CO alarm that is labeled as compliant with UL 2034, IAS 6-96, or CSA 6.19-01 for each habitable space that contains an unvented combustion appliance.

C.9. Dust and lead. The work scope shall specify that contractors adhere to the requirements of CFR Title 40, Part 745, (lead-safe work practices) in any home constructed before 1978 where pre-existing paint finishes or dust may be disturbed as part of the work, as defined in the regulation. Such compliance may not be required when the owner has documentation from a certified inspector or risk assessor that the house is free of lead-based paint or has undergone lead abatement, as defined in the regulation.

C.10. Carbon monoxide alarm. The work scope shall specify a minimum of one CO alarm that is labeled as compliant with UL 2034, IAS 6-96, or CSA 6.19-01, to be installed per manufacturer's recommendations in the hallway(s) outside the bedroom area at each floor level.

C.11. Insulation: Where the work scope calls for added insulation, it shall specify that all installation adhere to manufacturer's instructions and/or any generally accepted industry standard (where applicable) for the specified product type.

C.12. Verification. The work scope shall specify verification of installed work, including all required HVAC performance testing in accordance with ANSI/ACCA 5 QI, as applicable,; combustion appliance testing in accordance with Annex B of this standard; and a confirmed HERS rating per the RESNET Mortgage Industry National Home Energy Rating Systems Standards.

Annex D (Normative): Knowledge Base and Skill Set for the HPA

The following comprise a list of knowledge base and skills necessary for comprehensive home energy audits:

D.1. Building Science Fundamentals

D.1.1. Basic Terms & Definitions (to comprehend and use)

D.1.1.1. Airflow in buildings / ducts: CFM, CFM50, CFM25, ACHnatural, ACH50, FPM

D.1.1.2. Equipment Efficiencies: AFUE, SSE, SEER, EER, HSPF

D.1.1.3. Power and energy: watts, BTU/hr, ton of refrigeration, watt-hours, BTU, therm, decatherm

D.1.1.4. Effective leakage area

D.1.1.5. Area weighted R-Value

D.1.1.6. Baseload / Seasonal energy use

D.1.1.7. Driving forces: Pressure, temperature, moisture differential

D.1.1.8. Thermal resistance / transmittance: R and U Values

D.1.1.9. Latent / Sensible heat: evaporation, condensation / specific heat, heat capacity

D.1.1.10. Duct total equivalent length

D.1.1.11. Dehumidification / Humidification

D.1.1.12. Pressure units: Inches of Water Column (iwc), Pascal (Pa)

D.1.1.13. Natural / mechanical ventilation

D.1.1.14. Net free area

D.1.1.15. Input / output capacity

D.1.1.16. Peak electrical demand

D.1.1.17. Permeability and perm rating

D.1.1.18. Standby loss

D.1.1.19. IAQ (indoor air quality): moisture, CO, dust

D.1.2. Principles of Energy, Air & Moisture

D.1.2.1. Thermodynamics: conduction, convection, radiation, ΔT

D.1.2.2. R-values & U-values

D.1.2.3. UA concepts

D.1.2.4. Parallel paths

D.1.2.5. Film coefficients

D.1.2.6. Buoyancy

D.1.2.7. Forced air flows

D.1.2.8. Solar (absorptance + reflectance + transmittance = 1.0)

D.1.2.9. Far infrared (emittance = absorptance; emittance, reflectance, absorptance, transmittance)

D.1.2.10. Factors that affect insulation performance: density, installation, moisture

D.1.2.11. House pressurization/depressurization by various forces

D.1.2.12. Heat gain / loss: internal, solar, heat transmission, air leakage

D.1.2.13. Power and energy: BTU content of fuels, capacity of combustion appliances and electrical appliances

D.1.2.14. Moisture transport mechanisms: bulk water, air leakage, diffusion, capillary action

D.1.2.15. Dew point

D.1.2.16. Relative humidity

D.1.3. Combustion Science

D.1.3.1. Combustion analysis: oxygen, flue-gas temperature, carbon monoxide

D.1.3.2. Carbon Monoxide (CO) testing of combustion appliances

D.1.3.3. Basics of: Combustion appliance venting, draft, and combustion air

D.1.3.4. Combustion safety issues: Combustion air, draft, worst case / baseline depressurization, spillage, backdrafting, unvented combustion appliances

D.2. Buildings and their Systems (Fundamentals)

D.2.1. Building Components

D.2.1.1. Basic duct configurations and components and associated problems

D.2.1.2. Basic hydronic distribution configurations and components and associated problems

D.2.1.3. Basic structural components of residential construction and potential ramifications on energy use

D.2.1.4. Identifying minimum rated features as defined in the National Home Energy Rating Technical Guidelines:

D.2.1.5. Identify and document the features of the rated home in accordance with the requirements of Section B.5. and Appendix A of the National Home Energy Rating Technical Guidelines.

D.2.1.6. Controls (standard, programmable, multi-zone thermostats)

D.2.1.7. Thermal boundaries and insulation applications

D.2.1.8. Basic electrical components and safety considerations

D.2.1.9. Basic fuel delivery systems and safety considerations

D.2.1.10. Basic bulk water management components (drainage, plumbing, gutters, sumps, etc)

D.2.1.11. Vapor barriers/retarders

D.2.1.12. Radiant barrier principles and installations

D.2.1.13. Understand fenestration types and efficiencies

D.2.1.14. Understand issues involved with basements, crawlspaces, slabs, attics, attached garages, interstitial cavities, and bypasses

D.2.1.15. Understand issues involved with ventilation equipment

D.2.1.16. Understand basic heating / cooling equipment components controls and operation

D.2.1.17. Understand basic DHW equipment components controls and operation

D.2.1.18. Identify common mechanical safety controls

D.2.1.19. Identify insulation types and R-Values

D.2.1.20. Understand various mechanical ventilation equipment and strategies: whole house, local, ERV, HRV, enthalpy, exchange

D.2.1.21. Ventilation exchanger efficiency, fan power and duty cycle characteristics

D.2.2. Conservation Strategies

D.2.2.1. Appropriate insulation applications and installation based on existing conditions

D.2.2.2. Opportunity for ENERGY STAR lighting and appliances

D.2.2.3. Identify duct sealing opportunities and applications

D.2.2.4. Understand importance of air leakage control and remediation procedures including interaction with insulation performance/ improvements

D.2.2.5. Blower door-guided air sealing techniques

D.2.2.6. Water conservation devices and strategies

D.2.2.7. Domestic Hot Water (DHW) conservation strategies

D.2.2.8. Heating & cooling efficiency applications

D.2.2.9. Proper use of modeling to determine heating and cooling equipment sizing and appropriate energy conservation measures (including impacts on energy use and humidity control)

D.2.2.10. Understand the use of utility history analysis in conservation strategies

D.2.2.11. Appropriate applications for sealed crawlspaces basements and attics

D.2.2.12. Appropriate applications for fenestration upgrades including modification or replacement

D.2.3. Comprehensive Building Assessment Process

D.2.3.1. Determine areas of customer complaints/concerns in interview

D.2.3.2. Understand / recognize need for conducting appropriate diagnostic procedures including when to refer to a specialist for further investigation

D.2.3.3. Interaction between mechanical systems, envelope systems and occupant behavior

D.2.4. Design Considerations

D.2.4.1. Appropriate insulation applications based on existing conditions

D.2.4.2. Understand ~~fire~~ local codes as necessary to apply home-performance in a code-approved manner.

D.2.4.3. Understand/recognize building locations where opportunities for retrofit materials and processes are needed to correct problems and/or enhance performance

D.2.4.4. Understand climate specific concerns

D.2.4.5. Understand indoor environment considerations for the environmentally sensitive

D.2.4.6. Understand impact of building orientation, landscape drainage, and grading

D.2.4.7. Opportunity potential renewable energy applications: geothermal , photovoltaic, wind

D.2.4.8. Understand impact of shading on heating / cooling loads

D.2.4.9. Awareness for solar gain reduction in cooling climate/solar gain opportunities in heating climates

D.2.4.10. Material and building durability

D.2.4.11. Understand need for modeling various options for heating, cooling and DHW applications, as well as other efficiency upgrades

D.3. Measurement and Verification of Building Performance (Fundamentals)

D.3.1. Applied Diagnostics & Troubleshooting

D.3.1.1. Application of measured air leakage test results

D.3.1.2. Understand building shell/envelope leakage as a function of pressure difference and the size of holes in the air barrier

D.3.1.3. Apply fundamental construction mathematics and unit conversions

D.3.1.4. Calculate building tightness levels (minimum ventilation requirements)

D.3.1.5. Ventilation calculations and strategies

D.3.1.6. Proper methods for identifying / testing fuel leaks

D.3.1.7. Blower door setup, accurate measurement and interpretation of results

D.3.1.8. Duct leakage testing (total leakage and leakage to outside): setup, accurate measurement and interpretation of results

D.3.1.9. Combustion Appliance Zone (CAZ): depressurization, spillage, draft, Carbon Monoxide (ambient and flue)

D.3.1.10. Carbon Monoxide (CO) evaluation: ambient

D.3.1.11. Proper applications and use of temperature measuring devices

D.3.1.12. Pressure pan and room to room pressure diagnostics

D.3.1.13. Pressure differentials and measurement techniques

D.3.1.14. Recognize contributing factors to comfort problems

D.3.1.15. Inspect for areas containing moisture or bulk water in undesirable locations

D.3.1.16. Measures of efficiency

D.3.1.17. Determination of efficiency (nameplate, age-based defaults, etc.)

D.3.1.18. Relative Humidity

D.3.1.19. Understand and inspect for basic electric safety (e.g. frayed wires, open boxes, etc)

D.4. BPI National Standards and Project Specifications

D.4.1. Comprehensive Building Assessment

D.4.1.1. Understand applicability content and intent of BPI National Standards

D.4.1.2. Recognize need for a professional local/state/national codes evaluation

D.4.1.3. Produce a scaled and dimensioned sketch of a home.

D.4.1.4. Be able to specify appropriate materials and processes needed for building performance projects

D.5. Analyzing Building Systems

D.5.1. Comprehensive Building Assessment

D.5.1.1. Recognize need for air sealing measures and their impact on other building systems

D.5.1.2. Recognize need for mechanical equipment improvements

D.5.1.3. Understand blower door use for identifying critical air sealing areas

D.5.1.4. Apply blower door test results in development of improvement strategies

D.5.1.5. Using safety testing results to develop appropriate recommendations

D.5.1.6. Determine appropriate method for assessing wall insulation levels

D.5.1.7. Identification of insulation defects and ability to account for them in energy analysis tool inputs.

D.5.1.8. Equipment control strategies for maximizing occupant comfort and minimizing energy consumption

D.5.2. Appliances and Lighting

D.5.2.1. Understand benefit for ENERGY STAR labeled lights and appliances

D.5.2.2. Understand impact on load associated with lighting and appliance retrofits including timers and controls

D.6. Conduct & Communications

D.6.1. Conservation Strategies

D.6.1.1. Present options for comprehensive conservation strategies that are consistent with sound building science practices

D.6.1.2. Understand the implications of building performance improvements on occupants and other building systems/components

D.6.1.3. Provide appropriate cost benefit analysis guidance

D.6.2. Personal Safety & Work Practices

D.6.2.1. Locations in which to identify indoor air quality issues

D.6.2.2. Material Safety Data Sheets

D.6.2.3. Isolation procedures for pollutants

D.6.2.4. Practice building science within your limits of professional competency

D.6.2.5. Precautions when working around chemical biological and other potential hazards

D.6.2.6. Understand role and responsibilities of the building analyst professional

D.7. Rating Procedure

D.7.1. Understanding construction documents

D.7.1.1. Building drawings

D.7.1.2. Specifications

D.7.2. Field data collection (including photo documentation)

D.7.2.1. Physical measurements

D.7.2.2. Completing scaled sketches

D.7.2.3. Measuring building dimensions

D.7.2.4. Determining building orientations

D.7.2.5. Measuring window overhang lengths and heights

D.7.2.6. Determining roof slopes, gable heights, etc.

D.7.2.7. Calculating gross and net areas and volumes.

D.7.3.Energy feature documentation

D.7.3.1. Energy Analysis (Software) tool data requirements

D.7.3.2. Developing and using field inspection forms

D.7.3.3. Organizing data entry procedures

D.7.4. Characterizing envelope features

D.7.4.1. Determining wall types

D.7.4.2. Determining window and door types and characteristics

D.7.4.3. Determining envelope insulation types, thickness, thermal characteristics and weighted average thermal values

D.7.4.4. Determining duct system characteristics (duct types, insulation value, location with respect to the thermal and air barrier)

D.7.5.Equipment efficiencies determination

D.7.5.1. Nameplate data

D.7.5.2. AHRI directories

D.7.5.3. Age-based defaults

D.7.5.4. In situ measurements

D.7.6. Performance testing

D.7.6.1. Envelope leakage

D.7.6.2. Air distribution system leakage

D.7.7.Local climate impacts

D.7.7.1. Major US climate zones

D.7.7.2. 97.5% and 2.5% design conditions

D.7.7.3. Cooling and heating design trade-offs

D.7.8. Utility prices

D.7.8.1. Revenue-based pricing

D.7.8.2. Reliable sources

D.7.9. Reports

D.7.9.1. Minimum reporting requirements

D.7.9.2. Improvement analysis

D.7.9.3. Projected and confirmed ratings

D.8. Operating Procedures and Office Administration

D.8.1. National guidelines and standards

D.8.1.1. Accreditation Procedures

D.8.1.2. Technical Guidelines

D.8.1.3. Training & Certification Standards

D.8.2. Understanding the Reference home and rating method

D.8.2.1. Reference Home as defined in B.2 of the National Home Energy Rating Technical Guidelines ("Twin" home concept): "The reference home is the geometric twin of the rated home, configured to a standard set of thermal performance characteristics, from which the energy budget, that is the basis for comparison, is derived."

D.8.2.2. HERS Score computation using the Normalized Modified Loads Rating Method

D.9. Uses of a Rating

D.9.1. Builder assistance

D.9.1.1. Cost effective building design assistance

D.9.1.2. Quality assurance assistance

D.9.1.3. Marketing

D.9.2. Program qualifications

D.9.2.1. EPA Energy Star

D.9.2.2. Utility

D.9.2.3. Other

D.9.3. Financing advantages

D.9.3.1. Energy Efficient Mortgages (EEM)

D.9.3.2. Energy Improvement Mortgages (EIM)

D.9.3.3. Energy Code compliance

D.9.3.4. Added appraisal value

D.9.3.5. Consumer education

D.9.3.6. Understanding real estate, financing and economic terminology

D.9.4. Dealing with clients

D.9.4.1. Understanding the business aspects of being a energy rater

D.9.4.2. Cultivating builder, banker and real estate partners.

D.9.4.3. Knowing who the customer is.

D.9.4.4. Providing excellent service.

D.9.4.5. Ethics and disclosure

Annex E (Informative): Testing Disclosure

E.1 Testing Disclosure. The report generated as a result of combustion appliance testing include a disclosure notice to inform the customer of the limitations under which the testing was conducted. The disclosure may include, but shall not be limited to, the following items:

"The results of the combustion appliance test do not represent the worst-case conditions for depressurization and do not take into account effects of the following:

- Fireplace or woodstove operation
- Exhaust fans rated at less than 150 cubic feet per minute, and appliances such as whole-house vacuum cleaners
- Exhaust effects attributable to combustion gas venting that draws air from the dwelling
- Powered attic fans
- Heat or energy recovery system exhaust on defrost cycle
- Exhaust from negative pressure sources in adjacent dwelling units
- All possible combinations of HVAC fan operation and damper and door operation
- Improper or incomplete installation and maintenance of appliances and venting
- Wind under conditions other than those during the test
- Stack effect variations over time
- Open windows
- Re-entrainment of exhaust gases via another pathway such as a window, air intake, or indirect building air leakage path
- Sustained off-cycle downdrafting in very cold weather, thereby chilling the flue and creating sustained backdraft conditions during operation
- Reduced chimney draft of solid fuel appliance at end of burn cycle
- Warm weather with little wind, potentially interfering with a water heater's proper venting against low depressurization levels

In addition, testing furnaces, boilers that do not heat the potable hot water supply, or space heaters, in weather conditions during which they would not normally be operating (i.e., warmer than 60°F) can provide positive spillage results not found when tested in their normal outdoor temperature range.

A Comprehensive Home Energy Audit is neither a building code inspection nor a safety assessment. Acceptance of a Comprehensive Home Energy Audit shall not constitute any warranty, expressed or implied, regarding potential building problems that lie outside the scope of the Home Performance Audit."

Annex F (Informative): Comprehensive Packages

A comprehensive home performance package may include (but need not be limited to) any or all of the following:

- Measures that bring ductwork and air handling equipment inside the thermal boundary
- Measures that bring the HVAC system in compliance with ANSI/ACCA 5 QI
- Upgrades to building enclosure
- Baseload reductions (such as efficient lighting and appliances)
- Water-saving measures
- Cooling load reductions such as shading devices
- Passive or active solar heating or water heating systems
- Replacement of equipment with high-efficiency, direct-vent or power-vented replacement(s), particularly when the total cost of repairs to existing equipment (including necessary combustion appliance testing) exceeds cost to replace or upgrade to a higher performance option
- Measures that meet or exceed applicable state or local codes set forth by the authority with jurisdiction

At a minimum and where possible, compliance with the requirements of the 2009 IECC for thermal components and mechanical systems is recommended. Upgrade to maximum amount possible when IECC requirements cannot be achieved. For example, when a wall cavity of limited depth is being insulated), the recommendation is to fill the cavity; where additional work is specified, such as interior drywall or replacement siding, the addition of rigid insulation to IECC levels may be included. For customers that are interested in beyond-code performance, levels higher than IECC may also be recommended as part of a “deep retrofit” package.

Annex G (Informative): Installation References

G.1 Installation references. The home performance auditor may be required to use these references, as applicable, in whole or in part, in the preparation of a work scope, or may cite these references directly in the work scope.

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 USA
Telephone: (610) 832-9585; Fax: (610) 832-9555; www.astm.org
***ASTM E 2112-07,* Standard Practice for Installation of Exterior Windows, Doors and Skylights**

Documents Published by ASHRAE (see above)
***ASHRAE 152-2004, Annex A* Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems**

Documents Published by Building Science Press
30 Forest Street, Somerville, MA 02143
Telephone: (978) 589-5100; Fax: (978) 589-5103; www.buildingsciencepress.com
***Builder's Guide to Cold Climates* (2006), by Joseph Lstiburek**
***Builder's Guide to Hot-Dry / Mixed-Dry Climates* (2004), by Joseph Lstiburek**
***Builder's Guide to Hot-Humid Climates* (2005), by Joseph Lstiburek**
***Builder's Guide to Mixed-Humid Climates* (2005), by Joseph Lstiburek**

Documents Published by the Air Conditioning Contractors of America (ACCA)
2800 Shirlington Road, Suite 300, Arlington, VA, 22206
Telephone: (703) 575-4477; www.acca.org
***Manual J - Residential Load Calculation, 8th Edition* (ACCA/ANSI Version 2.00, 2006)**
***Manual S - Residential Equipment Selection* (ANSI/ACCA 3 Manual S-2004)**
***HVAC Quality Installation Specification* (ANSI/ACCA 5 QI-2007)**

Documents Published by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI)
2111 Wilson Blvd, Suite 500, Arlington, VA 22201
Telephone: (703) 524-8800; Fax (703) 528-3816; www.ahrinet.org
Directory of Certified Product Performance published on-line at:
www.ahridirectory.org

Documents Published by NFPA (see above)
***NFPA 70®: National Electrical Code* (2008)**

Documents Published by the United States Environmental Protection Agency (EPA)
Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460
Telephone: (202) 272-0167; www.epa.gov/lead

***United States Code of Federal Regulations, Title 40: Protection of Environment, Part 745—Lead-based Paint Poisoning Prevention in Certain Residential Structures* (CFR40, Part 745)**