RESNET
Residential Energy Services Network

Setting the STANDARD for QUALITY

Results of Electronic Ballot of the RESNET Board of Directors on Recognizing the Texas Home Energy Raters Organization as a Home Performance Certification Program

May 4, 2009

The following are the results of the electronic ballot of the RESNET Board:

Shall RESNET recognize the Texas Home Energy Raters Organization request to be recognized as a home performance certification program to certify comprehensive home energy auditors under Section 705.3.2 of the RESNET standards?

The request from the Texas Home Energy Raters Organization is included as Attachment A. The organization's "Texas Home Energy Audit Technical Standard" is included as Attachment B.

Yes (19)	No (0)	Abstain (2)	Not Voting (0)
Ben Adams		Bruce Harley*	
Steve Byers		C.T. Loyd**	
Dennis Creech			
Philip Fairey			
Richard Faesy			
David Goldstein			
Andy Gordon			
Tom Hamilton			
Michael Holtz			
Mark Jansen			
Greg Nahn			
Lee O'Neil			
Kelly Parker			
Bill Prindle			
Robert Scott			
Daran Wastchak			
Erin Wiggins			
David Wilson			
Barb Yankie			

* Bruce Harley abstained because he was "quite uncomfortable with RESNET unilaterally doing what is in effect accrediting an organization as being equivalent to BPI, which is implicit in this process when you consider sections 404.2.1 and 705.3.2".

** C.T. Loyd abstained because of his close association with the Texas Home Energy Raters Organization

The application from Texas HERO to be Approved as Comprehensive Home Energy Audit Program was approved.

Attachment A

Texas HERO
Texas Home Energy Rating Organization

P.O. Box 11603
Fort Worth, TX 76110-0603
(866) 489-4376
www.txhero.org

Austin contact: (512) 845-9650

25 March 2009

Mr. Steve Baden
Executive Director
RESNET
P.O. Box 4561,
Oceanside, CA 92052.

Re: RESNET Recognition of Texas HERO Certification of Comprehensive Home Energy Auditors

Dear Steve:

Thank you for taking the time to visit with us on March 19, 2009 about our efforts to align Texas HERO's Texas Home Energy Audit program with RESNET. On behalf of the Board of Texas HERO, this will request RESNET approval of the following action:
Recognition of Texas HERO certification of comprehensive energy auditors based on the Texas Home Energy Audit Standard, as an equivalent home performance certification under Section 705.3.2 of the RESNET Standards.

The attached Texas Home Energy Audit Technical Standard will be the basis for our training and certification. It meets or exceeds RESNET's national minimum standards for comprehensive energy audits. It is intended for training RESNET-certified Raters to take a leading role in the existing home performance market, and qualify immediately for Texas utility-sponsored efficiency programs. It uses the existing framework of RESNET Rating Providers, overlaying audit Quality Assurance by Texas HERO beyond the requirements on Providers. It makes clear reference to RESNET Standards and states clearly its basis on those standards. Our certification is ready for implementation immediately, and responds to an urgent need in Texas for a recognized Auditor certification. RESNET recognition will help avoid confusion, or worse, program delays, awaiting a final RESNET Auditor certification process or eventual joint certification with RESNET/BPI.

Thank you again for your assistance and advice. We look forward to an early response that this petition is successful.

Sincerely,

Tom Fitzpatrick
Chief Operating Officer

Attachment B

Texas Home Energy Audit Technical Standard

April 15, 2009

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Texas Home Energy Audit Standard

1. Scope of Standard

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 inspecting the home, testing the home, analyzing the results, and identifying a scope of work for home improvements.

1.3. This Standard applies to existing site-constructed or manufactured, single- and multi-family residential buildings three stories or less in height, with the exception of hotels and motels.

1.4. Compliance with this Standard will 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.

1.5. 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.

1.6. Implementation or acceptance of a Texas HERO Texas Home Energy Audit shall not constitute any warranty, expressed or implied, regarding potential problems that lie outside the scope of expertise of the Texas HERO Home Energy Auditor.

1.7. Performance tests shall be performed according to Texas HERO approved protocols found in Appendix C of this Standard.

1.7.1. The estimated energy use information contained in the audit report does not constitute any guarantee or warranty of actual energy cost or usage.

1.7.2. Inspections performed to this Standard are not technically exhaustive, will not identify concealed conditions or latent defects, and are not intended to be an inspection of the structural integrity of the home or any other attribute of the home other than the home's energy features.

1.8. Texas HERO Home Energy Auditors may choose to use default values for features that are not present or available for inspection according to the exclusions listed in this Standard. Under no circumstances shall the Texas HERO Home Energy Auditor be required to use default values that are not allowed under this Standard to produce an audit.

1.9. The minimum audited features of a home are the:

1.9.1. Square footage of home.

1.9.2. Volume of conditioned space.

1.9.3. Age of home.

1.9.4. Foundation.

1.9.5. Walls.

1.9.6. Roof/ceiling.

1.9.7. Rim joists.

1.9.8. Doors.

1.9.9. Windows.

1.9.10. Skylights.

1.9.11. Air infiltration.

1.9.12. Heating and cooling equipment.

1.9.13. Heating and cooling distribution system.

1.9.14. Duct leakage.

1.9.15. Domestic water heating.

1.9.16. Light fixtures.

1.9.17. Appliances.

1.9.18. Passive solar design where applicable.

1.9.19. Solar water heating where applicable.

1.9.20. Renewable energy production where applicable.

2. Relationship to Federal Law, State Law and Local Regulation

2.1. This Standard recognizes that some Federal laws, laws of the State of Texas or local regulations may have additional requirements to those specified in this document. To the extent that such laws or regulations differ from this Standard, Federal law, Texas law or local regulation shall govern.

2.2. All worker safety procedures shall follow OSHA standards.

3. Referenced Standards

3.1. The documents listed in Appendix A are referenced in the text of this Standard and are to be used by the Texas HERO Home Energy Auditor in whole or in part to carry out the Texas Home Energy Audit.

3.2. The documents listed in Appendix B may be referenced within a scope of work for a contractor that is developed by the Texas HERO Home Energy Auditor during the course of the Texas Home Energy Audit.

4. Software Audit Tools

4.1. All software tools permitted for analysis shall be accredited by RESNET®. The approved software tools are listed on the Texas HERO website, www.txhero.org.

4.2. All software tools permitted for reporting shall be approved for specific programs by Texas HERO and the program sponsor.

4.3. Software analysis must be performed in order to complete a comprehensive assessment.

4.4. Auditors shall use newest versions within 30 days of release.

5. Texas Home Energy Audit Technical Guidelines

5.1. The following elements of this Standard are the technical guidelines for the Texas Home Energy Audit. This comprehensive home energy audit requires an initial interview with the home's occupant(s); a Visual Assessment; a Diagnostic Assessment; and software analysis.

5.2. These guidelines for Texas are based upon the latest edition of the Mortgage Industry National Home Energy Rating Systems Standardspublished by RESNET®.

5.2.1. This Standard is the governing standard for comprehensive home energy audits in Texas.

5.3. Texas HERO Texas Home Energy Audit Standards of Practice

5.3.1. The Texas HERO Home Energy Auditor shall be responsible for:

5.3.1.1. Inspecting and/or testing the home’s minimum audited features listed in this Standard.

5.3.1.2. Entering the data collected into an approved audit software tool for a comprehensive assessment (Visual and Diagnostic Assessment).

5.3.1.3. Providing the client with the home’s audit reports, including the standard conflict of interest disclosure form according to Section 5.5.

5.3.1.4. Providing consulting services to the client on how to improve the energy performance of the audited home.

5.3.1.5. Keeping the property where services are performed clean and orderly during the course of their work.

5.3.1.6. Removing all debris generated by their work at the completion of the services.

5.3.2. The Standards of Practice are **not intended to limit**Texas HERO Home Energy Auditors from:

5.3.2.1. Including other inspection services, systems, or components in addition to those required in the standards of practice. This Standard is a minimum standard and does not prevent an Auditor from performing more comprehensive inspections and testing.

5.3.2.2. Undertaking the energy improvements of the home as long as the Auditor provides the conflict of interest disclosure form referred to in Section 5.5 of this Standard to the client and Texas HERO.

5.3.3. The Texas HERO Home Energy Auditor is **not required** by this Standard **to:**

5.3.3.1. Perform any action or make any determination outside the scope of this Standard.

5.3.3.2. Audit any outbuildings not directly connected to the main house.

5.3.3.2.1. Outbuildings should be a separate audit with separate reporting and should only be audited if conditioned and reflect residential use of space.

5.3.3.3. Determine:

5.3.3.3.1. the condition of systems or components that are not readily accessible.

5.3.3.3.2. the remaining life of any system or component.

5.3.3.3.3. compliance with regulatory requirements such as construction codes (although these should be considered when making recommendations for improvements).

5.3.3.3.4. future conditions including but not limited to failures of systems or components.

5.3.3.3.5. market value of the home or its marketability.

5.3.3.3.6. the existence of environmental hazards including mold.

5.3.3.3.7. the effectiveness of any system installed or method used to control or remove suspected hazardous materials.

5.3.3.3.8. the presence of potentially dangerous plants or animals including termites and diseases.

5.3.3.3.9. the acoustical properties of any system or component.

5.3.3.4. Offer or perform:

5.3.3.4.1. any act or service contrary to law.

5.3.3.4.2. engineering or design services.

5.3.3.4.3. HVAC system design or sizing consultation.

5.3.3.4.4. indoor air quality consultation.

5.3.3.4.5. work in any trade or professional service other than as a Texas Home Energy Auditor.

5.3.3.4.6. any warranty or guarantee of any kind exclusive of this Standard.

5.3.3.5. Operate any system or component that:

5.3.3.5.1. Is shut down or inoperable.

5.3.3.5.2. Does not respond to normal operating conditions.

5.3.3.6. Shut off valves.

5.3.3.7. Inspect or test systems or components that are not installed in the rated home, are located in areas that are not entered in accordance with this Standard, or in detached structures.

5.3.3.8. Enter any area or perform any procedure or operation that, in the opinion of the Home Energy Auditor, is likely to be dangerous to the Auditor or others or may damage the property, systems or components.

5.3.3.9. Move any suspended ceiling tiles, personal property, furniture, debris, equipment, plants, soil, ice, or snow.

5.3.3.10. Dismantle any system or component except as explicitly required in this Standard.

5.4. Auditor Proposal

5.4.1. Prior to the start of any work, provide the client a written proposal (physical or electronic) that covers the work that will be performed by the Texas HERO Home Energy Auditor. It must include:

5.4.1.1. an estimate of the cost of the audit.

5.4.1.2. a clear description of the type of audit to be performed, the type of information that will result, and the form in which the findings will be provided to the client;

5.4.1.3. a standard Conflict of Interest Disclosure (RESNET® or equivalent); and

5.4.1.4. a clear statement that the recommended scope of work which results will be suitable for bidding by others.

5.5. Standard Conflict of Interest Disclosure

5.5.1. The conflict of interest disclosure form must include whether the Auditor or auditing company is:

5.5.1.1. receiving a fee for the audit;

5.5.1.2. receiving a commission related to the audit;

5.5.1.3. providing HVAC design, indoor air quality consulting, moisture control consulting, performance or diagnostic testing beyond that required for an audit;

5.5.1.4. financing portions of the payments on the home;

5.5.1.5. the seller of the home or their agent;

5.5.1.6. an employee, contractor or consultant to the servicing utility company;

5.5.1.7. a supplier or installer of HVAC systems, insulation systems, duct sealing, air sealing, windows, window shading systems, energy efficient appliances, or is a builder/developer.

5.5.2. The Standard Disclosure form produced by an accredited software audit tool is acceptable to meet this requirement.

5.6. Initial Interview

5.6.1. Prior to (or in conjunction with) initiating data collection within the home, the Auditor shall conduct an interview with the client to identify occupant behaviors impacting energy use, occupant perceived problems or concerns relating to energy use; occupant records relating to energy use (e.g., utility bills or maintenance history); and characteristics of the home affecting energy consumption.

5.6.2. Record the address of the home and utility company identifier (meter number).

5.6.3. The interviewer shall attempt to determine from the client the following information, either over the phone, in person or via an Internet-based portal by asking the following questions or their equivalent:

5.6.3.1. ”How many people live in this home?”

5.6.3.2. ”What year was your home built?”

5.6.3.3. ”How long have you lived there?”

5.6.3.4. ”Do you own or rent?” (Note: Renters must have express written permission from homeowner prior to having an audit performed.)

5.6.3.5. ”Do you have comfort complaints?” (try to get as specific as possible: where in the home are they uncomfortable, are they trying to heat or cool the space they’re in when they’re uncomfortable, etc)

5.6.3.6. “Has there been any recent work on your home (within the past year)?”

5.6.3.7. “Would you consider having improvements performed based upon the results of the Home Energy Audit?”

5.6.3.8. “Do you keep the windows and exterior doors closed when operating the HVAC system?

5.6.3.9. “How often do you open your windows instead of using the air conditioner to maintain comfort?”

5.6.3.10. “Where are the HVAC air handlers located?”
5.6.3.10.1. “Are they gas or electric?”

5.6.3.11. ”How often do you change the filter in the HVAC system(s)?”
5.6.3.11.1. “What type of filter do you use?”

5.6.3.12. “How often do you have the HVAC system checked for maintenance?”

5.6.3.13. “Have you ever received any instruction in the operation of their HVAC system and thermostat?”

5.6.3.14. “Do you have a programmable thermostat? How do you use it?”

5.6.3.15. “Where are the water heaters located?”
5.6.3.15.1. “Are they gas or electric?”

5.6.3.16. ”Do you use compact fluorescent light bulbs?”

5.6.3.17. “Do you turn on the kitchen exhaust fan when cooking?”

5.6.3.18. “Do you turn on the bath exhaust fan when bathing/showering?”

5.6.3.19. ”Do you have high bill complaints?” (Get copies of their utility bills)

5.6.3.20. “Do you have a basement or usable crawlspace? If so, how do you use it?”

5.6.3.21. Where is the attic access?

5.6.3.22. “Do you have complaints about condensation on windows, any plumbing or roof leaks, or moisture problems near the foundation?”

5.6.3.23. “Do you have a swimming pool or hot tub? If so, when do you use it? How long does the pump run? Is it heated and how? Is the swimming pool or hot tub inside your home? If so, how is that space ventilated?”

5.6.3.24. “Do you have any wood-burning stoves or fireplaces in the home? If so, how do you use them?”

5.6.3.25. “Do you have any unvented fireplaces or space heaters in the home? If so, how do you use them?”

5.7. Visual Assessment

5.7.1. Graphic record.

5.7.1.1. Record by sketch, annotated digital photographs or annotated drawing the:

5.7.1.1.1. Floor plan with exterior dimensions;
5.7.1.1.2. Orientation of the home;
5.7.1.1.3. Roof configuration;
5.7.1.1.4. Attached porch roofs;
5.7.1.1.5. Cantilevered floors;
5.7.1.1.6. Bay windows;
5.7.1.1.7. Roof dormers;
5.7.1.1.8. Attached garage.

5.7.2. Exterior

5.7.2.1. Condition of siding, trim, fascia, soffit areas, window and door head trim, jambs and sills.

5.7.2.1.1. “Excellent” indicates no weather damage, new condition.
5.7.2.1.2. “Good” indicates little weather damage, nearly new condition.
5.7.2.1.3. “Fair” indicates some moderate weather damage (10% - 20% of surface area).
5.7.2.1.4. “Poor” indicates weather damage greater than 20% of the surface area.

5.7.2.2. Any shading or solar exposure that may affect comfort levels.

5.7.2.3. Opportunities for renewable technology (i.e., access to sunlight on south side).

5.7.3. Foundations

5.7.3.1. Record type of foundation (basement, crawlspace, slab, mixed).

5.7.3.1.1. Crawlspaces

5.7.3.1.1.1. Check for intact vapor barrier with 100% coverage of the ground.
5.7.3.1.1.2. Check for signs of water damage, mold and standing water.
5.7.3.1.1.2.1. This does not require the auditor to verify the presence of mold- only use signs of mold as a means of determining moisture damage.
5.7.3.1.1.3. Check the foundation walls for insulation and sealing.

5.7.3.1.1.4. Check crawlspace for HVAC system components and combustion appliances.

5.7.3.1.2. Basements

5.7.3.1.2.1. Check for walkout (daylight) access.

5.7.3.1.2.2. Check for whether the basement is conditioned or unconditioned.

5.7.3.1.2.3. Check location of insulation (whether in the walls or ceiling).

5.7.3.1.2.3.1. Check amount of insulation.

5.7.3.2. Check to see if the ground slopes away from the home at least 6” over the first 10’.

5.7.3.3. Note if roof runoff water is directed away from the foundation with downspouts and splash blocks.

5.7.3.4. Note if there is a foundation drain system.

5.7.4. Conditioned Framed Floors over Unconditioned Space

5.7.4.1. Examine for unsealed holes or penetrations in the floor system and rim/band joist.

5.7.4.2. Note if there is insulation in the floor system. Record the R-value.

5.7.4.3. Note if the rim/band joists are insulated. Record the R-value.

5.7.4.4. Note if there are HVAC ducts in the floor system.

5.7.5. Exterior Walls

5.7.5.1. Inspect the home for penetrations and leakage paths to the outside:

5.7.5.1.1. Plumbing penetrations on exterior walls.

5.7.5.1.2. Electrical penetrations on exterior and interior walls.

5.7.5.2. Is there insulation in the wall? Record the R-value.

5.7.6. Interior Moisture

5.7.6.1. Record evidence of high moisture levels in living space such as moisture deposition or damage:

5.7.6.1.1. under windows;

5.7.6.1.2. on exterior walls behind furniture;

5.7.6.1.3. in corners of closets on exterior walls;

5.7.6.1.4. in other areas of stagnation and thermal bridging;

5.7.6.1.5. at flooring adjacent to doors and windows where leakage may occur;

5.7.6.1.6. around HVAC supply outlets;

5.7.6.1.7. on the ceiling;

5.7.6.1.8. at a slab floor / exterior wall interface (at baseboards).

5.7.7. Windows

5.7.7.1. Record the types of window (type of frame, number of panes).
5.7.7.2. Record the orientation of the windows.
5.7.7.3. Note if the windows that are double-pane have a low-emissive coating on inside surface of the outer pane (surface 2).
5.7.7.4. Note presence and condition of weather-stripping.

5.7.8. Doors

5.7.8.1. Record the types and condition of exterior doors (material, extent of glazing, etc.).
5.7.8.1.1. If mechanical room containing combustion equipment is present within conditioned space, record type of door and whether it is weather-stripped, has a threshold or functioning stop, and has a self-closing device.
5.7.8.2. Check the exterior doors for presence and condition of weather-stripping.
5.7.8.3. Note if the strike plates need to be adjusted so that the door will close and latch properly.
5.7.8.4. Check each exterior door and mechanical room door within conditioned space for a threshold that functions:
5.7.8.4.1. secure attachment to subfloor or slab;
5.7.8.4.2. proper adjustment so that it meets the bottom of the door;
5.7.8.4.3. appear to keep out drafts (presence of an auxiliary “draft stop” device would indicate a failure).

5.7.9. Skylights

5.7.9.1. Check for air and water leaks around the skylights.
5.7.9.2. Check the skylight shaft walls for insulation and air barrier, if the attic is vented and the conditioned space boundary is defined at the attic floor.
5.7.9.3. Determine the orientation of the skylights.

5.7.10. Ceilings

5.7.10.1. Check for infiltration paths to the outside or buffered zones.
5.7.10.1.1. Check three duct boots for sealing to the ceiling surface material.
5.7.10.1.2. Ventilation fans at the ceiling/fan interface.
5.7.10.1.3. Recessed light fixtures at the ceiling/fixture interface.

5.7.11. Attics

5.7.11.1. Note type, location and integrity of attic access.
5.7.11.2. Check the chases for ductwork and chimneys; should be capped and sealed.
5.7.11.3. Check chases created by interior architectural features such as arched doorways, columns, and dropped soffits; should be capped and sealed.
5.7.11.4. Check penetrations through the top plates (electrical, plumbing) for sealing.
5.7.11.5. Record the R-value installed in attic kneewalls.

5.7.11.6. Check the attic kneewalls for sheathing (have an air barrier on the attic side). Attic kneewalls located within cathedralized attics (insulation along the roofline, no venting) are excluded from the requirements for insulation and air barriers or sealing.

5.7.11.7. Check the attic kneewalls for airsealing.

5.7.11.8. Examine the joists under attic kneewalls for blocking.

5.7.11.9. Record the R-value and type of insulation in attic floor.

5.7.11.10. Check for the presence of bath or kitchen exhaust ducts improperly venting into the attic.

5.7.12. Roofs

5.7.12.1. Check if there is insulation applied to the underside of the roof sheathing, creating a cathedralized attic.

5.7.12.1.1. Note R-value if insulation is present.

5.7.12.1.2. Check for evidence of air leakage such as outside light entering the attic at the attic perimeter.

5.7.12.2. Check if there is a radiant barrier applied to the roof.

5.7.12.3. Check if the soffit vents are blocked with insulation.

5.7.12.4. Check if there is adequate attic venting.

5.7.12.4.1. Record the number of open attic vents and estimated venting net free area following the International Residential Code for One- and Two-Family Dwellings- 2003.

5.7.12.4.1.1. Calculate attic square footage.

5.7.12.4.1.2. Divide attic square footage by 150 to determine net free area required.

5.7.12.4.1.3. Divide result by 2 to get intake and exhaust net free area.

5.7.12.4.1.4. Convert result to square inches by multiplying by 144.

5.7.12.5. Check if there are powered attic fans in use.

5.7.12.5.1. Check if powered attic fan is solar powered.

5.7.12.6. Check for signs of roof leaks or condensation in the attic.

5.7.13. HVAC Systems and Ductwork

5.7.13.1. Verify thermostat settings.

5.7.13.1.1. If the thermostat has a thermometer, take a measurement of the temperature at the thermostat to confirm thermostat accuracy.

5.7.13.2. Record the type, manufacturer and model number and the location of the installed HVAC equipment.

5.7.13.3. Examine the air handler fan to see if it is dirty (a prime indicator of poor airflow).

5.7.13.4. Determine the age and initial rated efficiency of the installed HVAC equipment.
5.7.13.5. Check all condensate lines for signs of blockage or leaks.
5.7.13.6. Verify the presence of secondary overflow drain pans at the air handler units (indoor coils).
5.7.13.6.1. Verify presence of a condensate drain line connected to drain pans.
5.7.13.6.2. Verify presence of a float disconnect switch.
5.7.13.6.3. Verify that all other water producing devices (dehumidifiers, ERV's, etc.) are draining to the outside of the home.
5.7.13.7. Check all exhaust vents for proper fitting and termination.
5.7.13.8. Note any issues with the outdoor coil such as air flow obstructions or blocked coil fins.
5.7.13.9. Check the refrigerant line set for insulation, both outside the home and within attics, basements or crawlspaces.
5.7.13.10. Inspect the ductwork to determine the quality of design and installation.
5.7.13.10.1. Examine supply and return ducts for proper sizing and installation to promote optimum airflow.
5.7.13.10.1.1. Measure return grilles and calculate net free area.
5.7.13.10.1.1.1. Net free area is typically 80% of the gross area.
5.7.13.10.1.2. Note whether filter is installed at the grille or at the return plenum-air handler connection.
5.7.13.10.1.3. Note type of filter (MERV rating, etc).
5.7.13.10.2. Note if all duct components are properly sealed.
5.7.13.11. Record the type, location, R-value of insulation and condition of exterior surface of ductwork, including obvious leaks.

5.7.14. Domestic Water Use
5.7.14.1. Determine fuel type, manufacturer, model number, approximate age, storage capacity and location of water heater. If yellow EnergyGuide label is present, efficiency rating (EF) can be determined by dividing 150 by the annual consumption on the label in therms for natural gas and 4,396 by the annual consumption on the label in kWh for electric.
5.7.14.2. Verify water heater thermostat settings.
5.7.14.3. Verify that the water heater has a pressure relief valve and it is not obstructed.
5.7.14.4. Check for signs of leakage at the water heater.
5.7.14.5. Conduct visual inspection of the water heater and exposed distribution system for opportunities to improve efficiency by insulating exposed pipes, installing heat traps, and installing tank insulation.
5.7.14.6. Determine the type and number of plumbing fixtures.
5.7.14.6.1. Estimate the average distance from the water heater.
5.7.14.6.2. Check for piping insulation levels.
5.7.14.6.3. Check for location of piping (attic, crawlspace, slab, etc.).

5.7.15. Lighting

5.7.15.1. Ask about the usage pattern and determine the estimated percentage of incandescent light fixtures.
5.7.15.2. Note the type of lighting in high usage areas (incandescent, compact fluorescent, etc) and whether controlled with a dimming switch.
5.7.15.2.1. If compact fluorescents are installed in a fixture controlled with a dimming switch, they should be capable of dimming. This is an opportunity to educate the homeowner.
5.7.15.3. Observe or ask if they turn off lights and ceiling fans when no one is in the room. If not, use this as an educational opportunity to explain the impact of choices made in the operation of the home.

5.7.16. Appliances
5.7.16.1. Record location, type, age, manufacturer, model numbers and estimated efficiency of major appliances such as dishwashers, refrigerators, freezers, washing machines and dryers.
5.7.16.2. Note presence and location of exhaust fans.
5.7.16.2.1. Note if they are vented outdoors.
5.7.16.3. Record presence and manufacturer, model number, and type(s) of combustion equipment; identification of visually identifiable problems including flame rollout, blocked chimney, and disconnected vent connectors.
5.7.16.4. Record presence, manufacturer, model number, and EER of room air conditioners; are they seasonally installed, semi-permanently installed, etc.
5.7.16.4.1. Check the weather seal condition of room air conditioners.
5.7.16.5. Record presence and operability of smoke detectors.
5.7.16.6. Record presence and operability of carbon monoxide detectors.

5.7.17. Garages
5.7.17.1. If garage is attached:
5.7.17.1.1. Check garage for operable exhaust fan;
5.7.17.1.2. Check garage for combustion appliances;
5.7.17.1.3. Check garage for air handler unit(s);
5.7.17.1.4. Check garage for exposed ductwork;
5.7.17.1.5. Check garage for attic access;
5.7.17.1.6. Check garage for additional appliances such as freezers and refrigerators.

5.8. Diagnostic Assessment

5.8.1. After (or in conjunction with) Visual Assessment determinations, the Auditor shall conduct diagnostic tests in the following home performance areas:
5.8.1.1. Gas leak testing (if combustion appliances are within conditioned space);
5.8.1.2. Envelope infiltration;
5.8.1.3. Duct leakage;
5.8.1.4. Supply airflow testing (optional);
5.8.1.5. Zonal pressure differences (optional);
5.8.1.6. Carbon monoxide testing (if combustion appliances are present within conditioned space);

5.8.1.7. Combustion safety worst case depressurization (if combustion appliances are present within conditioned space).

5.8.2. Prior to conducting any test that affects the normal operating pressures in the home, inquire whether a person is present in the home that has environmental sensitivities (asthma, allergies, chemical sensitivity, etc.). If a person is present with environmental sensitivities, do not perform such tests. The Auditor shall either reschedule the test for a time when they will not be present or ask them to leave the home during the testing process.

5.8.3. Gas Leakage Testing

5.8.3.1. If there is a strong odor indicating gas buildup within the home, the occupants and Auditor shall leave the house and the appropriate authorities and utility providers shall be notified from outside the home. Ensure that switches are not operated while exiting and no ignition concerns are present. The audit may not proceed until the proper authorities have deemed it safe to re-enter the home.

5.8.3.2. If there is NO strong odor indicating gas buildup within the home, determine if there are gas leaks in the fittings and connections of the appliance and natural gas/liquid propane supply lines following the protocols in Appendix C.

5.8.4. Envelope Infiltration

5.8.4.1. Conduct a single point (50 Pa) blower door depressurization / pressurization test according to ASHRAE/ANSI Standard 119-1998 RA-2004 Air Leakage Performance for Detached Single-Family Residential Buildings as modified by RESNET® or ASTM E1827-96(2007) “Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door”.

5.8.4.1.1. If peeling lead-based paint or friable asbestos containing materials are present within the home, do not perform a blower door depressurization test until those conditions are remediated.

5.8.4.1.2. If a home has suspended ceiling tiles creating a buffer zone within the building envelope, measures shall be taken to prevent significant pressure changes within the buffer zone (such as moving some tiles to create openings between the buffer zone and the conditioned space).

5.8.4.1.3. If the blower door test results in an Envelope Leakage Ratio less than 0.25 (25 cfm_{50} per 100 sq. ft. of above grade envelope Surface area), it will be necessary to recommend that mechanical ventilation per ASHRAE Standard 62.2-2007 is installed.

5.8.4.1.4. If obvious infiltration sites are revealed during the initial Visual Assessment, it is not required to perform a blower door test to comply with this Standard. However, a blower door test may be required for compliance with a specific program such as a Standard Offer Program from a utility.

5.8.4.1.4.1. Enter the defaults per RESNET® Standard Section 303.5.1.5.2.3 for infiltration in the software audit tool.

5.8.4.1.4.1.1. Summer infiltration rate is 1.2 x 0.48 x W.

5.8.4.1.4.1.2. Winter infiltration rate is 1.6 x 0.48 x W.

5.8.4.1.4.1.3. W is the ASHRAE Weather factor and is found in ASHRAE Standard 136 or in the “site information” location of the software audit tool.

5.8.4.1.5. If no obvious infiltration sites are present during the initial Visual Assessment or if the audit is performed to verify improvements, the blower door test must be performed and the results entered into the software audit tool.

5.8.5. Duct Leakage

5.8.5.1. Conduct a single point (25 Pa) fan pressurization/depressurization test (Total Leakage Test) on the duct system according to ASHRAE/ANSI Standard 152-2004 Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems as modified by RESNET® or ASTM E1554-07 “Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization”.

5.8.5.1.1. If there are obvious leakage sites revealed during the Visual Assessment on the initial audit, it is not required to perform a duct leakage test to comply with this Standard. However, a duct leakage test may be required for compliance with a specific program such as a Standard Offer Program from a utility.

5.8.5.1.1.1. Enter the RESNET® Default Distribution System Efficiencies for Inspected Systems into the software audit tool.

5.8.5.1.2. If there are no obvious leakage sites or if the audit is performed to verify improvements made, the duct leakage test must be performed.

5.8.5.2. Determine the amount of duct leakage normalized by conditioned floor area served by each system. This is done by dividing the fan pressurization test results for each system by the conditioned floor area served by the system (cfm_{25}/sf).

5.8.6. Airflow Testing

5.8.6.1. Determine restrictions to airflow by one of the following:

5.8.6.1.1. Visual assessment indicates gross failure for design and installation according to industry standards (such as NAIMA Fibrous Glass Duct Installation Check List, Flexible Duct Performance and Installation Standards 4th edition) referenced in Appendices A & B;

5.8.6.1.2. Static pressure test per the protocol in Appendix C;

5.8.6.1.3. Return airflow test per the protocol in Appendix C;

5.8.6.2. Pressure pan testing may be used to help determine the location of leaks within the air distribution system.

5.8.6.3. Airflow testing will be required when a Manual J load calculation is going to be performed.

5.8.7. Zonal Pressure Differences

5.8.7.1. If the bedrooms do not have ducted returns, jumper ducts or some other method of equalizing the pressure between the room and the main body of the house when the bedroom door is closed, the Zonal Pressure Difference Test must be performed per the protocols in Appendix C.

5.8.7.2. Determine the amount of pressurization or depressurization caused by closing rooms off from the area served by a central return, creating pressure zones

within the home and measuring the changes between the main body of the home and the outside to determine dominant duct leakage, as well as measuring the pressure differences between the closed off rooms and the main body of the house to determine pressure imbalances caused by inadequate return paths.

5.8.8. Carbon Monoxide Testing

5.8.8.1. This test is only required when combustion appliances are within conditioned space.

5.8.8.2. Test the occupied zone of spaces containing combustion appliances for carbon monoxide following the protocol in Appendix C.

5.8.8.3. CO testing shall be performed continuously while performing a Worst Case Depressurization test.

5.8.9. Worst Case Depressurization

5.8.9.1. This test is only required when combustion appliances are within conditioned space.

5.8.9.2. Determine if there is likelihood for combustion appliances to have spillage within the building envelope when exhaust fans are operating by following the protocol in Appendix C.

5.8.9.3. Check the combustion appliance zone for the presence of flammable or explosive material near a combustion source.

5.9. Analysis for Recommendations

5.9.1. Cost Effectiveness

5.9.1.1. Use the audit tool to generate an improvement analysis report.

5.9.1.1.1. Simplified inputs or equivalent are acceptable.

5.9.2. Interaction with other measures

5.9.2.1. Determine if the recommended improvement will interact with other recommended improvements and explain that interaction to the client.

5.9.3. Budget priorities.

5.9.3.1. Determine with the client whether each cost-effective improvement measure will meet the budget considerations of client.

5.9.4. Emission Reduction Estimate

5.9.4.1. If requested by the client, use the software reports to demonstrate the emission reduction estimate based upon the recommended improvements.

5.9.4.1.1. These reports should provide estimates of CO_2, SO_x, and NO_x reductions.

5.9.5. Scopes of work for contractors

5.9.5.1. Any changes to the building envelope, including measures that affect air infiltration, windows, and insulation levels or placement, will require a new Manual J load calculation to be performed.

5.9.5.2. The scopes of work for recommended improvements will be determined by the Auditor and shall be based upon the findings of the assessment and the client’s budget.

5.9.5.3. The scopes of work shall clearly identify for the client any remedial actions which require prompt attention, affect safety, or require a licensed trade.
5.9.5.4. The scopes of work shall provide sufficient specification that the client may obtain reasonably comparable bids from alternative sources for making recommended improvements.
5.9.5.5. All scopes of work should include this statement:" **The estimated energy use information contained in the audit report does not constitute any guarantee or warranty of actual energy cost or usage.**"
5.9.5.6. Use the prioritized lists found in Appendix D to recommend repairs / replacements.
5.9.5.7. Emphasis shall be on:
5.9.5.7.1. bringing air distribution system components inside the building envelope when possible,
5.9.5.7.2. improving airflow and total HVAC system efficiency,
5.9.5.7.3. upgrades to the building envelope,
5.9.5.7.4. improvements to the base load profile (lighting and appliances).
5.9.5.8. The scopes shall reflect the "house as a system" approach, recognizing that measures may have different consequences due to interactions between the measures. It is strongly suggested that the following statement be included whenever a fireplace or combustion appliance is located within the building envelope:
5.9.5.8.1. "These scopes of work are not a list of recommendations that may be implemented alone or in combinations; any exclusions or variations to these scopes may result in the home not operating properly and may include the risk of flue gas spillage, backdrafting, carbon monoxide production or moisture problems within the home."

5.9.5.9. If combustion appliances exceed the carbon monoxide limits based upon the results of the testing performed, a qualified, trained technician shall clean and tune the appliance to restore it to proper operating conditions prior to further testing.
5.9.5.10. If the home has unvented combustion appliances, recommend they be disconnected and replaced with vented combustion appliances.
5.9.5.11. If unvented combustion appliances are not replaced with vented combustion appliances or electric appliances, no airsealing measures can be performed on the home.

5.10. Documentation
5.10.1. Reports to client
5.10.1.1. Upon completion of the audit, provide the client with a written record (physical or electronic) of the audit and resulting recommendations within 3 working days. It must include:
5.10.1.1.1. General findings of audit;
5.10.1.1.2. General recommendations for improvements;
5.10.1.1.3. Scopes of work for suggested improvements;
5.10.1.1.4. Software generated improvement analysis.
5.10.1.2. Upon delivery of the written record and recommendations, the Auditor or their representative must go over the report with the homeowner and discuss the results.

5.10.1.2.1. The Auditor or their representative must disclose any safety or health issues revealed during the audit and obtain a signed release from the homeowner indicating that they were made aware of the issues.

5.10.1.2.2. The Auditor or their representative should use this as an educational opportunity to discuss how occupant behavior affects energy consumption.

5.10.1.2.3. The Auditor or their representative should provide information on relevant utility-based programs that may help the homeowner.

5.10.1.3. Recommended measures that are going to be installed at a later date need to be recorded.

Appendix A: Auditor Referenced Standards

1. www.resnet.us 2006 Mortgage Industry National Home Energy Rating Systems Standards, published by the Residential Energy Services Network, latest version,

2. www.ashrae.org ASHRAE/ANSI Standard 119-1998 RA-2004 Air Leakage Performance for Detached Single-Family Residential Buildings, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.,

3. www.ashrae.org ASHRAE/ANSI Standard 152-2004 Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.,
4. www.astm.org ASTM E1998-02(2007) "Standard Guide for Assessing Depressurization-Induced Backdrafting and Spillage from Vented Combustion Appliances", published by ASTM International,

5. www.astm.org ASTM E1827-96(2007) "Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door", published by ASTM International,

6. www.astm.org ASTM E1554-07 "Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization", published by ASTM International,

7. www.rimainternational.org Reflective Insulation, Radiant Barriers and Radiation Control Coatings, published by the Reflective Insulation Manufacturers Association- International,

8. www.acca.org (currently in draft) Protocols for Verifying HVAC Systems to the ACCA Quality Installation Standard, published by the Air Conditioning Contractors of America,

9. www.acca.org Verifying ACCA Manual J® Procedures, published by the Air Conditioning Contractors of America,

10. www.acca.org Verifying ACCA Manual S® Procedures, published by the Air Conditioning Contractors of America,

11. www.acca.org Verifying ACCA Manual D® Procedures, published by the Air Conditioning Contractors of America,

12. www.naima.org NAIMA Fibrous Glass Duct Installation Check List, published by the North American Insulation Manufacturers Association,

13. www.ahridirectory.org AHRI Certification Directory, published by the Air-conditioning, Heating and Refrigeration Institute,

Appendix B: Scope of Work Referenced Standards

1. International Residential Code for One- and Two-Family Dwellings- 2003, published by the International Code Council, Inc., www.iccsafe.org

2. International Energy Conservation Code- 2006, published by the International Code Council, Inc., www.iccsafe.org

3. International Mechanical Code- 2003, published by the International Code Council, Inc, www.iccsafe.org

4. International Fuel Gas Code- 2003, published by the International Code Council, Inc., www.iccsafe.org

5. www.acca.org ANSI/ACCA Standard 5 QI-2007 HVAC Quality Installation Specification, published by the Air Conditioning Contractors of America,

6. www.acca.org Manual J, Residential Load Calculation, 8th edition, published by the Air Conditioning Contractors of America,

7. www.acca.org Manual D, Residential Duct Systems,3rd edition, published by the Air Conditioning Contractors of America,

8. www.acca.org Manual S, Residential Equipment Selection, published by the Air Conditioning Contractors of America,

9. www.acca.org Manual RS, Comfort, Air Quality, & Efficiency by Design, published by the Air Conditioning Contractors of America,

10. www.acca.org Manual T, Air Distribution Basics, published by the Air Conditioning Contractors of America,

11. www.acca.org Manual H, Heat Pump Systems, published by the Air Conditioning Contractors of America,

12. www.acca.org Manual G, Selection of Distribution Systems, published by the Air Conditioning Contractors of America,

13. www.ashrae.org ASHRAE Standard 62.2 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.,

14. www.ashrae.org ASHRAE Standard 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size , published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.,

15. www.astm.org ASTM Standard C1015-06 “Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation”, published by ASTM International,

16. www.astm.org ASTM Standard C1320-05 “Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction”, published by ASTM International,

17. www.astm.org ASTM Standard C727-01 (2007)e1 “Standard Practice for Installation and Use of Reflective Insulation in Building Constructions”, published by ASTM International,

18. ASTM Standard C1158-05 “Standard Practice for Installation and Use of Radiant Barrier Systems in Building Constructions”, published by ASTM International, www.astm.org

19. ASTM Standard E2112-07 “Standard Practice for Installation of Exterior Windows, Doors and Skylights”, published by ASTM International, www.astm.org

20. Flexible Duct Performance and Installation Standards 4www.flexibleduct.org th edition, published by the Air Diffusion Council,

21. Fibrous Glass Duct Construction Standards, 5www.naima.org th edition, published by the North American Insulation Manufacturers Association,

22. FTC Trade Regulation Rule 16 CRF 460, Labeling and Advertising of Home Insulation, published by the Federal Trade Commission, www.ftc.gov

Appendix C: Testing Procedures

(This appendix is part of this Standard. It contains requirements necessary for conformance to the Standard.)

Equipment Calibration All equipment capable of calibration must be calibrated according to manufacturer's specifications and proof of calibration submitted to Texas HERO upon completion of calibration testing. Suggested Calibration Schedule:

- Manometers: at least once every 12 months
- Flow Hoods: at least once every 12 months
- Infrared Thermometers: at least once every 12 months
- Anemometers: at least once every 12 months
- CO detectors: at least once every 12 months
- Infrared cameras: at least once every 12 months
- Equipment such as fans for conducting pressure test should be examined every month to ensure they are in good working order and are producing reliable field test results. Follow the manufacturer's instructions for performing routine maintenance checks.

Gas Leakage Test

1. Equipment needed:
1.1. Combustible gas detector capable of measuring 20 ppm

1.2. Leak detection fluid (non-corrosive)

2. Inspect all fittings and joints in supply lines and appliances

3. Confirm suspected leaks with leak-detection fluid

4. Identify for repair or replacement any kinked, corroded or visibly worn flexible gas lines and any connectors manufactured prior to 1974.

Blower Door Test Blower door tests should be conducted according to ASHRAE/ANSI Standard 119-1998 RA-2004 as modified by RESNET® or ASTM E1827-96(2007) referenced in Section 3.3 of the Standard. Following are general guidelines for the infiltration test. Please follow the manufacturer's instructions for operating the specific piece of equipment used.

1. Installing the Blower Door (example based on Minneapolis Blower Door)

1.1. Install the frame and nylon panel in an exterior doorway of a large open room.

1.2. Attach the gauge mounting board and fan speed controller to a door, or to the aluminum frame gauge hanger bar, using the C- clamp on the back of the mounting board.

1.3. Secure the gauge onto the mounting board (using the Velcro strips) and connect tubing to the gauge. The outside reference tube goes to the bottom tap on the “A” side, while the fan reference tube goes to the top tap on the “B” side.

1.4. Run approximately 3 - 5 feet of the remaining end of the outside reference tubing outside through one of the patches in the bottom corners of the nylon panel. Be sure the outside end of the tubing is well away from the exhaust flow of the Blower Door fan and is protected from the wind.

1.5. Install the Blower Door fan, with the Flow Rings and No-Flow Plate attached, into the large hole in the nylon panel. The exhaust side of the fan should be outside, and the inlet side of the fan (the side with the Flow Rings) should be inside the building.

1.6. Insert the female plug from the fan speed controller into the receptacle located on the fan electrical box. The remaining cord (power cord) should be plugged into a power outlet that is compatible with the voltage of the fan motor.

1.7. Check that the fan direction switch is set to blow air out of the building.

1.8. The remaining end of the fan reference tubing should now be connected to the pressure tap on the Blower Door fan electrical box.

2. Prepare the house

2.1. Ensure that the building envelope is complete by closing all windows and doors, attic access panels and pull downs, attic kneewall doors, and fireplace dampers. Auditor should NOT temporarily seal holes that exist when the house is being lived in (such as bathroom vent fans).

2.2. Ensure that all doors within the building envelope are open. Closet doors may remain closed if the closets do not have supply registers.

2.3. Adjust all combustion appliances so that they do not turn on during the test. If a gas fired water heater is on and in the conditioned space, turn it to “pilot.” Hint: leave the keys to the vehicle driven to the site as a reminder to turn it back when you are done.

2.4. Be sure all fires are out in fireplaces and wood stoves. Close all fireplace and wood stove doors to prevent scattering of ashes.

- Fireplaces should be treated with caution as damage may occur to carpeting during a depressurization test if the flue damper is inoperable or left open and the doors do not provide a good seal. Some strategies to deal with it include laying a small rug in front of

the fireplace to protect the home's carpeting, sweeping and vacuuming all the ashes out and applying wet newspapers over any ash residue, etc.

2.5. Turn off any exhaust fans, vented dryers, and room air conditioners.

2.6. Tape off any outside air intakes IF they are continuously operating. These may be taped outside the house if accessible. If not, the outside air intake may be taped inside the house. If taping the outside air intake requires the duct to be disconnected, the Auditor may request that an HVAC contractor detach the outside air intake.

3. Perform Air Leakage Test

3.1. Turn the Blower Door fan on and bring the house to a -50 Pa pressure difference with respect to the outside

3.2. Record the cubic feet per minute of leakage at the 50 Pa pressure difference

3.3. If using a digital manometer, it may produce the CFM_{50} value based upon the ring configuration input of the gauge. The configuration input on the gauge must match the actual ring configuration on the blower door fan for it to be accurate.

3.4. If using a magnahelic gauge or a digital gauge that does not convert fan pressure to fan flow, record the fan pressure value and look up the flow in the table provided for that fan by the fan manufacturer.

3.2. If there is a separate attached living space (like an above garage apartment), two blower door tests must be run. The CFM_{50} for the tests shall be added together.

3.3. When done, break down all equipment and reconnect the outside air intakes. If you do not reconnect the outside air intakes, you must tell the homeowner that they are still disconnected so that the HVAC contractor can take care of it. Turn air handlers and water heaters back to original settings.

Duct Pressurization Test

Duct pressurization (or depressurization) tests should be conducted according to ASHRAE/ANSI Standard 152-2004 as modified by RESNET® or ASTM E1554-07 referenced in Section 3.3 of the Standard. Following are some general guidelines for the duct leakage test. Please follow the manufacturer's instructions for operating the specific piece of equipment used.

1. Connect the duct pressurization (or depressurization) fan to the duct system
1.1. Choose a location to install the duct pressurization fan. In single, double or triple returned systems, the largest and closest return to the air handler is usually the best choice.

1.2. If the filter is thicker than 1 inch, remove it prior to running the test.

1.3. Connect the fan speed controller to the fan and plug it into an 110V outlet.

1.4. Install the flow ring which you think best matches the needed fan flow.

2. Prepare the duct system and house for the test

2.1. Temporarily seal off all remaining supply and return registers, and combustion or ventilation air inlets which are connected to the duct system. Tape off any fresh air intakes. These may be taped outside the house if accessible. If not, the fresh air intake may be taped inside the house. If taping the fresh air intake requires the duct to be disconnected, the auditor may insist that an HVAC contractor detach the fresh air intake.

2.2. Remove all central filters (i.e. in air handler or return plenum).

3. Connect hoses to the Pressure Gauge

3.1. Select a location to measure duct pressure. If the duct system is reasonably airtight (e.g. less than 200 cfm_{25} of leakage), duct pressures can be measured at any supply register by inserting a hose into a supply outlet through the temporary register seal.

3.2. Connect hoses to the gauge. Attach the duct supply reference hose to the top tap on the “A” side and attach the fan reference hose to the pressure tap on the fan and the other end to the top tap on the “B” side.

4. Conducting the Test

4.1. Remove all rings from the blower door fan (Open Fan). Switch the flow direction to blow air into the home (pressurize the home).

4.2. Turn on the Blower Door fan by slowly turning the fan controller clockwise. As the fan speed increases, the building pressurization displayed on Channel A should also increase. Continue to increase the fan speed until the building pressurization shown on Channel A is between +20 and +30 Pascals. Do not waste time adjusting and re-adjusting the fan speed control to achieve a test pressure of exactly +25 Pascals.

4.3. When the house pressure is + 25 Pascals with respect to the outside AND the duct supply outlet pressure is 0 Pascals with respect to the house, the duct pressure is + 25 Pascals with respect to the outside.

4.4. Check (and adjust if necessary) the selected test Device (i.e. fan) and Configuration (i.e. Flow Ring) shown in the upper part of the gauge display to match the fan and Flow Ring being used in the test. If you change the Flow Ring on the fan, be sure to change the Configuration setting on the gauge to match the installed Ring.

4.4. Turn on the duct pressurization fan by slowly turning the fan controller clockwise. As the fan speed increases, the duct pressure displayed on Channel A should also increase from a negative pressure to zero. Continue to increase the fan speed until the duct pressurization shown on Channel A is 0 Pascals.

4.5. Channel B will now display the One-Point 25 Pascal Duct Leakage to the Outside estimate.

4.6. Record the duct system leakage (cfm_{25})

5. Calculate percent leakage by dividing the CFM_{25} by the floor area (in square feet) of the zone that HVAC system serves.

5.4. When test is complete, break down equipment, reconnect fresh air intake, replace air filters, remove tape from registers, and turn the air handler to its original settings.

Pressure Pan Test

The purpose of this test is to find the leakier duct runs in order to prioritize duct sealing efforts and can be used as a screening tool to identify whether duct sealing is a reasonable investment. It can also be used in the Quality Assurance program to verify duct sealing was performed.

1. Set the blower door test up per the protocol in Appendix C.

1.1 Seal off any outside air ventilation intakes connected to the duct system
1.2 Depressurize the home to -50 Pa
1.3 Check the pressure difference between the home and any unconditioned buffer zones adjacent to the home that contain ductwork
1.3.1 The pressure difference should be > 45 Pa
1.3.2 If it is significantly less than 45 Pa, the pressure pan readings will be difficult to interpret
1.4 Connect a pressure tube between the pressure pan apparatus and a manometer (input tap)
1.5 Place the pressure pan apparatus over each grille or register, ensuring a tight seal
1.5.1When the pressure reading on the gauge stabilizes, record the reading

2. Benchmarks

2.1 A tight duct system:
2.1.1 All readings will be < 1.5 Pa and no more than two readings will be > 2.0 Pa
2.1.2 A leaky duct system:
2.1.2.1 3 or more readings are > 2.0 Pa

Static Pressure Test (alternate test method, State licensing as HVAC technician working for a State licensed HVAC contractor required)

Tools Needed:

- Manometer

- Two lengths of 3/16-in. (inside diameter) rubber tubing, about 3’ long

- Static Pressure Probe(s)

- 3/8-in. bullet tip drill bit or a “deep socket”

- A 1-in. outside diameter x ½-in. inside diameter x 4 1/2-in. long sheath to use over the drill bit

- 3/8-in. plastic hole plugs

Testing Procedure

1. Locate the appropriate places to drill the test holes on the supply side (+) between the air handler and the coil, and on the return side (-) between the filter and the air handler.
    1.1. Stay away from any coils, cap tubes, condensate pans, or circuit boards to avoid damage.
    1.2. Always look before you drill.

2. Drill test holes using a 3/8-in. drill bit with a metal piercing tip.
        2.1. A bullet tip drill makes a clean round hole.
            2.1.1. Make sure to use your drill bit sheath (described above) to prevent from drilling into the coil.
            2.1.2. Be sure to penetrate any duct liner to get a good reading.

3. Push one end of the tubing onto the static pressure probe.
    3.1. Place the other end of the hose on the HIGH (+) pressure port of the gauge.
    3.2. Zero the gauge following manufacturer’s instructions.

4. Record the positive (+) static pressure by inserting the static pressure probe through the test hole on the supply side into the air stream with the tip facing into the airflow.

4.1. The static pressure probe must be held in place while the value is recorded.

5. Record the negative (-) static pressure by moving the tube from the HIGH to the LOW-pressure port on the gauge and inserting the static pressure probe through the test hole in the return side with the tip facing the airflow.
    5.1. Record the negative static pressure.

6. Insert hole plugs in the test holes when testing is complete.

7. Calculate the system’s Total External Static Pressure by adding the two values.

7.1. Ignore the positive and negative signs when adding the pressure readings together.
    7.1.1. For example:

- The supply static pressure reading is (+) 65 Pa

- The return static pressure reading is (-) 52 Pa

- The total system static pressure is 117 Pa

- This is converted to IWC by multiplying 117 Pa by 0.004 = 0.468 IWC (there are 0.004 IWC per Pa) and can be compared with the manufacturer's values

Supply Outlet Airflow

Supply outlet airflow can be measured with a flow hood or an anemometer. The equipment used should have a NIST certificate for calibration and have an accuracy rate of 2% (velocity) for anemometers and 5% for flow hoods.

1. Turn the airhandler on to run at highest fan speed.

2. For anemometers, calculate the free area of the supply outlet.
    2.1. If measuring at the duct outlet, use the following:
        - 4" round duct = 0.087 sq. ft.

- 5" round duct = 0.136 sq. ft.

- 6" round duct = 0.196 sq. ft.

- 7" round duct = 0.267 sq. ft.

- 8" round duct = 0.348 sq. ft.

- 10" round duct = 0.545 sq. ft.

- 12" round duct = 0.785 sq. ft.

- 14" round duct = 1.068 sq. ft.

- 18" round duct = 1.766 sq. ft.

- 24" round duct = 3.14 sq. ft.

2.2. If measuring at the face of the grille or register, multiply the area of the grille or register (in square feet, sq. ft.) by 0.80 to get the free area.
    2.2.1. To calculate the area of the grille/register in square feet, multiply the length by the width of the grille/register and then divide the result by 144 to convert to square feet.
2.3. Record the flow reading for each supply grille/register after the flows have stabilized.

3. For flow hoods:

3.1. Set the apparatus to read supply airflow.

3.2. Place the apparatus in a centered position over each supply grille/register.

3.3. Record the flow reading after the flows have stabilized.

Return Inlet Airflow

Return inlet airflow can be measured using an anemometer, a flow hood or a pressure plate.

1. If using an anemometer, follow the instructions in “Supply Outlet Airflow” and record the reading for each return inlet.

2. If using a flow hood, follow the instructions in “Supply Outlet Airflow” except set the flow hood to read return airflow instead of supply airflow

3. If using a pressure plate, follow the manufacturer’s instructions for use. Since the pressure plate also requires measuring static pressure, licensure by the State is required.

Zonal Pressure Difference Test

1. To measure the pressure changes that occur within the home when the HVAC system is operating (dominant duct leakage):

1.1. Set the blower door up with the rings and “No Flow” plate installed on fan.

1.2. Measure the base- line stack effect with the gauge and record it.

1.3. Keeping the gauge set up to measure the pressure difference between the house and outside, turn on the air handler

1.4. Record the change in pressure between the house and outside

2. To measure the effect of closing the master bedroom door, close the master bedroom door.

2.1. Record the total pressure difference between the house and the outside.

3. To measure the effect of closing all the interior doors, (after the master bedroom ZPD has been recorded), close all interior doors that are connected to main living space.

3.1. Record the total pressure difference between the house and the outside.

4. To measure the effect of zonal pressure imbalances caused by the HVAC system, the test may be performed with blower door set up with rings and “No Flow” plate installed OR with all exterior doors closed.

4.1. Turn on all the air handlers and close all the interior doors.

4.2. Connect a hose to the “A” input tap on the gauge.

4.3. Leave “A” reference tap open and set the gauge to measure pressure.

4.4. Stand in the main body of the house and insert end of hose under each door (including combustion closet and basement).

4.5. Record the pressure difference between each room and the main body of the home, reading from the “A” side only.

Carbon Monoxide Test

1. Equipment used shall:
    1.1. Be capable of measuring carbon monoxide (CO) levels from 0 to 2,000 ppm (parts per million)

    1.2. Have a resolution of 1 ppm

    1.3. Have an accuracy rate of + 5%

    1.4. Be calibrated annually by the manufacturer and evidence of the calibration shall be submitted to Texas HERO's Technical Director.

2. Take a measurement of CO levels within the home upon entering to establish a baseline.
    2.1. Do not measure near combustion appliances while they are operating.

3. For atmospherically vented appliances:
    3.1. Take a measurement of flue gases at burner outlet

    3.2. Appliance must operate for at least 5 minutes before taking sample

    3.3. Take sample during worst case depressurization test

4. For direct or power vented appliances:
    4.1. Sample must be taken at vent connection

    4.2. Appliance must operate for at least 5 minutes before getting sample

    4.3. Take sample during worst case depressurization test

5. For gas fired ovens:

    5.1. Open a window or door to the outside

    5.2. Remove any foil or cooking utensils within the oven

    5.3. Verify that the oven is not in self-cleaning mode

5.4. Turn oven on to highest temperature setting.

5.5. Close the oven door and begin monitoring the CO levels in the kitchen, 5 feet from the oven at waist height.

5.6. Measure the CO levels within the oven vent.

5.6.1. Samples must be taken while burner is firing.

5.6.2. Operate burner for at least 5 minutes while sampling flue gases.

5.6.3. If CO levels are higher than 100 ppm, repeat the flue gas sampling until the CO levels stop falling

5.6.4. Record the lowest CO reading in ppm and turn off oven.

5.6.4.1. If measured CO levels are between 100-300 ppm, a CO detector should be installed and the homeowner notified that a qualified technician should repair/tune-up the appliance.

5.6.4.2. If measured CO levels are higher than 300 ppm, an exhaust fan capable of intermittent exhaust of 100 cubic feet per minute should be installed and the homeowner notified to call a qualified technician for service.

6. If an appliance fails to meet manufacturer's benchmarks for CO production, the Auditor should notify the homeowner that they need to call a technician to have the appliance repaired and tuned-up.

Worst Case Depressurization Test

This test procedure measures the pressure in the Combustion Appliance Zone (CAZ) and provides visual evidence of spillage potential.

1. Visually inspect venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion or other deficiencies that could cause an unsafe condition.
2. Inspect burners and crossovers for blockage and corrosion.
3. Inspect furnace heat exchangers for cracks, openings or excessive corrosion.
4. Close all the exterior doors and windows of the home.
5. Close any interior doors between the CAZ and the remainder of the house.
6. Measure the baseline pressure difference between the CAZ and outside (ambient) and baseline CO levels. Connect a hose to the outside and the "A" reference tap on the gauge and connect a hose to the combustion appliance zone and the "A" input tap (or leave it open if the gauge is within the zone). Set the gauge to read pressure.
7. Turn on all exhaust fans in the home (kitchen range hood, bath exhaust, clothes dryer, etc.) that exhaust air outside the building envelope.
8. Turn on the air handler.
9. Close fireplace damper(s) if fireplace is present.

10. Record net change in pressure difference within the CAZ (with respect to the outside) between baseline and worst case depressurization conditions.
11. Turn on combustion appliance with the smallest Btu capacity. Operate appliance for 5 minutes then measure CO levels at the appliance and check appliance draft using a smoke pencil at the draft diverter. If the smoke moves away from the draft diverter toward the appliance and not up the flue vent, the appliance has spillage under worst case depressurization.

- 11.1. If spillage occurs under worst case depressurization, retest under natural conditions.
  - 11.1.1. Turn off the combustion appliances
  - 11.1.2. Turn off the exhaust fans
  - 11.1.3. Open the interior doors
  - 11.1.4. Let the vent cool
  - 11.1.5. Test CO and spillage under natural conditions.
    - 11.1.5.1. If the appliances fail under natural conditions, a qualified technician should repair and tune-up the appliance.

12. Turn on all the other combustion appliances, one at a time, within the CAZ and repeat step 11 on each of them.

13. If the CO levels are higher than 35 ppm within the CAZ, stop the test and turn the combustion appliances off. Open all the exterior doors and windows. It is strongly suggested that the Auditor not enter the home until the CO levels drop below 35 ppm, but the Auditor should use their best judgment on when to re-enter and re-test. The combustion appliance causing the increase in CO levels needs to be repaired by a qualified technician prior to completing the combustion safety tests.

Informative Appendix D: Prioritized Recommendations

(This appendix is not part of this standard. It is informative and does not contain requirements necessary for conformance to the standard.) These recommendations are not requirements, nor detailed specifications, but are intended to be a guide for the Auditor in making prioritized recommendations to the homeowner. These recommendations reflect best practices for common conditions found in existing homes and reflect common practices as found in Home Performance with ENERGY STAR® programs. Each home is unique and may require additional measures or altered measures as recommended in this Appendix. It will be the responsibility of each Auditor to make the appropriate recommendations to match the audit findings, the client's budget and the health and safety of the home's occupants.

Foundations

1. If there is bulk water in the crawlspace or basement, it should be removed.
    1.1. This can be done with the installation of a sump pump that pumps the water to daylight away from the house or with the installation of a gravity drainage system through the foundation walls. The source of the moisture must be discovered and dealt with.

2. If the crawlspace doesn't have a vapor barrier that covers the ground 100%, one should be installed. Use at least a 10-mil black polyethylene sheet, although sometimes a thicker material is needed such as StegoWrap.
    2.1. Black color is recommended, as condensation visible through clear plastic is sometimes disconcerting to some homeowners.

3. If the ground doesn't slope away from the home at least 6" over 10' (5% slope), then it should be re-graded to achieve that. This may require the use of swales to divert water away from the foundation, particularly if the home is down a hill from another house.

4. If the gutters or downspouts are missing, they should be installed or repaired so that water landing on the roof is diverted away from the foundation system.

5. If there are signs of mold in the crawlspace, it should be removed. Spraying it with bleach is not an appropriate solution.

    5.1. Identify the source of contamination

    5.2. Identify the extent of contamination

    5.3. If the area is less than 30 square feet, it can be remediated without calling in a professional. If it is over 30 square feet, it is highly recommended that a professional mold remediator is called in. Interview and check references

    5.4. Plan for the safe removal of the contamination

    5.5. A depressurized zone should be set up to prevent the spread of mold spores throughout the home. If the mold is in a basement or crawlspace, the home

above can often be pressurized more easily than the crawlspace or basement depressurized by using a blower door.

5.6. Workers should wear safety goggles, rubber gloves and respirators (NIOSH N95) to help prevent reactions to the mold. Protective coveralls, booties, etc, should be removed and bagged and thrown away at the end of each work day and should not be worn anywhere outside the depressurized zone.

5.7. Start remediation

5.8. Remove infested material that cannot be cost effectively cleaned. It needs to be placed in sealed bags and removed through the nearest exterior door or window to prevent the spread of the contamination.

5.9. Clean the materials that can be salvaged.

5.9.1. If mold is present on solid lumber, it may be just a surface contamination that can be removed by scrubbing with a sponge and warm, soapy water. The water should be dumped out away from the foundation when it gets dirty. Materials that have lots of glue may start to delaminate and may need to be removed.

6. Damaged materials should be repaired or replaced

7. Damp spaces should be dried out before closing up

8. Vacuum the work area and formerly contaminated surfaces with a HEPA-filtered vacuum

9. If there are no drainage problems around the foundation and no moisture problems within the crawlspace or basement, the vents should be closed and the foundation walls insulated to R-10 (2004 IECC Climate Zone 4), R-5 (2004 IECC Climate Zone 3) and R-3 (2004 IECC Climate Zone 2).

9.1. This will require that the space become conditioned and any combustion appliances in that space must be sealed combustion, direct vent units (or replaced with electric heat pumps and/or water heaters). This will change the HVAC load on the home so a new load calculation according to the latest ACCA Manual J Standard will be required.

10. When practical and cost-effective, exposed slab edges should be insulated with an R-10 foam board (Climate Zone 4), R-5 foam board (Climate Zone 3) and protected with a borate-based termiticides and either a membrane and stucco or a fiber cement product. Coordination with local pest control and code officials is strongly encouraged.

11. Changes to the placement of the building envelope will change the load profile on the home and a new load calculation will need to be performed according to the latest ACCA Manual J Standard.

Conditioned Framed Floors over Unconditioned Space

1. All holes in a framed floor over unconditioned space should be air sealed.
    1.1. Some of these holes can be quite large and will require the use of sheet material to do so. This can become very tricky with the amount of penetrations in floors- it can be more cost effective to condition a basement or crawlspace than to airseal and insulate a framed floor over those spaces.
    1.2. Block and seal chases for ductwork
    1.3. Seal under bathtubs and toilets
    1.4. Seal penetrations through the bottom plates of the interior walls (electrical wires, plumbing)
    1.5. Seal around duct boot penetrations in the subfloor

    2. If the floor isn't insulated, it should be insulated with spray foam insulation or other method to reduce air infiltration to at least an R-19.
        2.1. If any other type of insulation is used, the framed cavity must be completely filled and supported at the bottom of the floor joist. The insulation must be in complete contact with the subfloor and installed according to ASTM Standard C1015-06 "Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation" or ASTM Standard C1320-05 "Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction". This can be achieved with a loose fill insulation such as cellulose or fiberglass and netting that is fastened to the underside of the floor joists and supported with wooden lath nailed perpendicular to the joist every 3'.

Above Grade Walls

1. Attic kneewalls should be insulated to R-18. This can be done with R-13 in a 2x4 cavity and a layer of R-5 foam board placed on the attic side, or R-19 in a 2x6 cavity with sheathing placed on the attic side. The insulation should be installed according to ASTM Standard C1015-06 "Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation" or ASTM Standard C1320-05 "Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction". The attic side rigid air barrier must be sealed at the seams and all penetrations.

2. If the exterior walls are not insulated, they can be insulated by pumping loose-fill insulation such as cellulose into the cavity. Cellulose can be pumped in from the outside by removing a strip of siding or from the inside by cutting a hole in the drywall (or lath & plaster) at the cavities.
    2.1. Don't forget to insulate the areas above windows and doors and below windows! All insulation materials must be installed according to ASTM Standard C1015-06 "Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation" or ASTM Standard C1320-05 "Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction" as appropriate.

    3. Seal the holes in the exterior walls around electrical fixtures, plumbing fixtures, windows, doors and baseboards (if the home is built on a slab). Foam gaskets that are placed under outlet covers on the interior side of the wall are almost completely

ineffective. Windows, doors and baseboards can be air sealed by removing the trim and sealing the holes with low-expansion foam.

Windows

1. Whenever possible, windows should be shaded from direct summer sun with permanent overhangs, awnings or shade screens.

2. If the windows are not double-pane, low-e, they should be replaced with windows that have a U-factor < 0.40 and a Solar Heat Gain Coefficient <0.40.

2.1. The priority is to replace unshaded windows on the:

2.1.1. west,

2.1.2. east,

2.1.3. south,

2.1.4. north.

2.2. This will change the HVAC load on the home and a new load calculation will need to be performed according to the latest ACCA Manual J Standard.

3. Replacement windows should be installed according to ASTM Standard E2112-07

Doors

1. If the doors do not have a functioning threshold, the existing threshold should be replaced with a new threshold, making sure to adjust it for the door and sealing it to the subfloor.

2. If the door doesn't close properly, adjust the strike plate and hinges until it does. Sometimes the door needs to be planed at the edges due to the house shifting over time.

3. If the door doesn't have weather-stripping at the stops, weather-stripping should be added. The best kind is the bulb type.

4. If an exterior door is replaced, the replacement doors should be installed according to ASTM Standard E2112-07

Skylights

1. If there is water entering the home around a skylight, the skylight should be checked for proper flashing.

1.1. The flashing should shed water from surface to surface. At the side of the skylight nearest the ridge of the roof, the head flashing should be under the felt underlayment. The flashing along the sides should be "stepped" so that as the water runs along the sides of the skylight, it is shed from shingle top to shingle top. The flashing should be sealed to the skylight unit with tar or some other sealant approved by the manufacturer.

2. If the skylight shaft walls are not insulated, they should be according to ASTM Standard C1015-06 "Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill

Thermal Insulation” or ASTM Standard C1320-05 “Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction” as appropriate.

Ceilings, Attics & Roofs

1. Determine if it is cost effective to insulate along the roofline and create a sealed, conditioned attic space. This is typically cost effective if there are ducts and HVAC equipment in the attic, but not always. If it is cost effective, the roofline should be insulated with open cell spray foam to at least an R-21 (about 6”).

2. If the roofline is going to be insulated, all vents, passive and powered, must be sealed off.

3. If the attic floor is going to remain the building envelope and the roofline is not going to be insulated, a radiant barrier system should be installed on the undersides of the rafters from soffit to ridge. Try to get at least 80% coverage of the roof sheathing. This radiant barrier can be in the form of foil-faced kraft paper or bubble-pack. If it can be installed all the way down to the soffit, it will also act as an insulation dam to keep wind from moving through the insulation and the insulation from spilling into the soffit. A radiant barrier system, if installed, must comply with ASTM Standard C1158-05 as noted in Section 3.3 of this Standard.

4. The holes between the attic and the house should be sealed. The big holes are chases for ducts and chimneys, unblocked joists under attic kneewalls, and holes in the top plates for electrical and plumbing lines. When sealing around chimneys and vents, make sure to maintain at least 3” of clearance from combustible materials.

5. If there is no attic insulation and it is not cost-effective to insulate along the roofline, seal penetrations and have R-38 blown in with rulers every 300 square feet and an affidavit card indicating the density and amount of insulation used.

6. If the attic floor is insulated with less than R-30, have R-19 blown over the top of the existing insulation after all the penetrations are sealed.

7. Disconnect any powered attic fans, even if they are solar powered.

8. Any changes to the insulation levels or placement will change the heating and cooling load profile, requiring a new load calculation to be performed according to the latest ACCA Manual J Standard

9. Clear any blocked soffit vents. The best combination for a vented attic is soffit and ridge vents. Gable vents rely upon wind, a fairly unpredictable strategy, while soffit and ridge vents rely upon the stack effect to draw outside air into the attic to replace the attic air that is escaping through the ridge vent.

Table of Net Free Vent Area

High Vent, Exhaust	**Net Free Attic Vent Area (square inches approximate)**
Filter vent, 8’ length	144 sq. in. (18 per lineal foot)
Shingle vent, 4’ length	72 sq. in. (18 per lineal foot)
Roof louver	50 sq. in.
Wind turbine, 12”	112 sq. in.
Rectangular gable louvers	
12” x 12”	56 sq. in.
12” x 18”	82 sq. in.
14” x 24”	145 sq. in.
18” x 24”	150 sq. in.
24” x 30”	324 sq. in.
Low Vent, Intake	
16” x 8”, under eave	56 sq. in.
16” x 6”, under eave	42 sq. in.
16” x 4”, under eave	28 sq. in.
Continuous soffit vent, 8’ length	72 sq. in. (9 per lineal foot)
Vented drip edge, 10’ length	90 sq. in. (9 per lineal foot)

Note: Be sure to check manufacturer’s specifications for individual products to determine the actual net free vent area.

Source: Principles of Attic Ventilation, published by Air Vent, Inc., Dallas TX

HVAC Systems & Ductwork

1. All equipment installations should meet the following Standards:
    - 1.1. 5 QI-2007 HVAC Quality Installation Specification,
    - 1.2. Manual J Residential Load Calculation, 8th edition, ACCA; should be based upon:
        - 1.2.1. improvements to be made,
        - 1.2.2. 99.6% and 0.4% outdoor design temperatures are permitted
        - 1.2.3. number of occupants = number of bedrooms plus one, or actual number of occupants living at the home full-time
    - 1.3. Manual S Residential Equipment Selection, ACCA
    - 1.4. Manual D Residential Duct Systems,3rd edition, ACCA
    - 1.5. Manual G Selection of Distribution Systems, ACCA
    - 1.6. Manual T Air Distribution Basics, ACCA
    - 1.7. Flexible Duct Performance and Installation Standards 4th edition, Air Diffusion Council
    - 1.8. Fibrous Glass Duct Construction Standards, 5th edition, NAIMA
    - 1.9. 2003 International Residential Code, ICC

2. If the HVAC is inside an unconditioned attic or crawlspace/basement, energy analysis should be performed to determine whether it is cost effective to alter the building envelope so that those spaces are conditioned.

3. Avoid recreating conditions that lead to poor indoor air quality such as:
    3.1. combustion appliances inside the building envelope that are not sealed combustion direct vent appliances
    3.2. moisture problems.

4. If the furnace was installed more than 17 years ago, it should be replaced with a higher efficiency furnace or an ENERGY STAR® labeled heat pump (Note: replacing a furnace with a heat pump may require the replacement of the ducts as heat pumps typically need to deliver larger volumes of air to meet the same load requirements, needing larger ducts).

5. If the central air conditioner was installed more than 14 years ago, it should be replaced with an ENERGY STAR qualified air conditioner
    5.1. All coils should be matched and rated by the AHRI

6. If the Air Source Heat Pump (ASHP) was installed more than 15 years ago, it should be replaced with an ENERGY STAR qualified heat pump
    6.1. Regardless of replacement, a heat pump should have an outdoor thermostat installed and set to prevent the use of electric resistance heat above the heat pump's balance point
    6.2. All coils should be matched and rated by the AHRI

7. If any flexible ductwork was installed more than 8 years ago, the flexible ductwork should be replaced

Domestic Water Use

1. Replace or supplement with solar DWH
2. If exposed pipes are uninsulated, they should be insulated with an appropriate level of pipe insulation
3. If heat traps are not present, a licensed plumber should install them. Many water heaters have heat traps built into the tank; the determination can be made by consulting the AHRI directory for water heaters and selecting the "Model Number".
4. If the tank is not insulated, it should be insulated with water heater tank insulation. The manufacturer's installation instructions should be followed.

5. If the water heater is more than 10 years old, it should be replaced with a high efficiency unit (Gas- EF >0.63, Electric- EF >0.93)

6. If the water heater is a combustion appliance and is located within the building envelope, it should be replaced with either a sealed combustion, direct vent appliance or an electric water heater or build a sealed combustion closet with insulated walls and ceilings, airsealed with the proper amount of combustion air supplied to the space. This combustion closet will

require a weather-stripped, exterior grade door with a self-closing device that latches the door securely.
7. If toilets use more than 1.6 gallons per flush, they should be replaced with one meeting the ENERGY STAR WaterSense Standard.
8. If showerheads use more than 2.5 gallons per minute, they should be replaced with ones meeting the ENERGY STAR WaterSense Standard (under development).

Lighting

1. Incandescent light fixtures in high use areas should be replaced with fluorescent fixtures or replace the bulbs with compact fluorescent light bulbs. Ensure the bulbs are manufacturer labeled for dimming if controlled by a dimming switch.
2. Bulbs in plug-in lamps should be replaced with compact fluorescent light bulbs
3. Recommendations should be made for occupancy sensor controls for some fixtures such as outdoor security lighting.

Appliances

1. If the refrigerator is older than 10 years, it should be replaced with an ENERGY STAR refrigerator
2. If the dishwasher is older than 9 years, it should be replaced with an ENERGY STAR dishwasher
3. If the clothes washer is older than 10 years, it should be replaced with an ENERGY STAR clothes washer
4. If the clothes dryer is older than 13 years, it should be replaced with a new clothes dryer

Occupant Behavior

1. Install a consumer feedback monitoring device that transmits the energy consumption data (for example, the HVAC system, the water heater (if electric) and the circuits in the largest use room) to a location easily visible to the occupants of the home.

Envelope Infiltration

1. The priorities for airsealing are:
    1.1. Chases for ductwork and chimneys
    1.2. Dropped ceilings

    1.3. Attic access doors, pull-down stairs and scuttle holes
    1.4. Whole house fans
    1.5. Transitions in floor or ceiling heights that create exposed cavities to the crawlspace/basement or attic
    1.6. Between joists under attic kneewalls
    1.7. Under bathtubs
    1.8. Around combustion appliance vent pipes
    1.9. HVAC closets that are inside conditioned space but are connected to unconditioned space (hall closet with attic above, for example)

1.10. Interface between the home and attached garage (if present)
1.11. Fireplace inserts
1.12. Recessed can lights in insulated ceilings
1.13. Exhaust fan outlets through exterior walls
1.14. Duct boot penetrations through insulated ceilings and floors
1.15. Electrical and plumbing penetrations through top and bottom plates of interior and exterior walls
1.16. Window and door rough openings
1.17. Electrical fixtures in walls
1.18. Windows and doors

2. Based on Diagnostic Assessment:
2.1. Determine the Envelope Leakage Ratio (ELR) of the home by dividing the blower door test result by the total insulated shell area (building envelope floors, walls, ceilings) (cfm_{50}/sf).
2.2. If the ELR is > 1.5, airseal until you have achieved a 25% reduction in air infiltration
2.3. If the ELR is between 0.45 and 1.5, airseal until you have achieved a 20% reduction in air infiltration
2.4. If the ELR is less than 0.45, airseal until you have achieved a 10% reduction in air infiltration
2.5. No airsealing shall be performed if unvented combustion appliances remain in the home
2.6. No airsealing shall be performed if the combustion appliance zone (CAZ) does not have sufficient make-up air
2.7. Mechanical ventilation shall be installed according to ASHRAE Standard 62.2-2007 if the home has an ELR less than 0.25
2.7.1. Whole house mechanical ventilation supplied to the home shall meet the minimum requirements of ASHRAE Standard 62.2-2007, Table 4.1a.
2.7.2. Whole house mechanical net exhaust flow shall not exceed 7.5 cubic feet per minute per 100 square feet per ASHRAE Standard 62.2-2007, Section 4.5.1.

Ventilation Air Requirements, cfm

Floor Area, sq ft	Bedrooms 0-1	2-3	4-5	6-7	>7
<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

ASHRAE 62.2-2007 Table 4.1a

Zonal Pressure Differences

1. If closing the Master Bedroom door creates a pressure difference greater than 1 Pascal with respect to the outside, one of the following should be installed:
    1.1. Return duct sized to return the amount of air supplied to the room with a grille face velocity less than 350 feet per minute (typically 120% of the supply duct area) OR
    1.2. Jumper duct sized to provide a return path back to the main part of the home; the required area of the jumper duct is equal to the supply area multiplied by 1.2

2. If closing all the interior doors creates a pressure difference greater than 2 Pascals with respect to the outside, one of the following should be installed:
    2.1. Return ducts sized to return the amount of air supplied to the closed off spaces with a return grille face velocity less than 350 feet per minute OR
    2.2. Jumper ducts sized to provide a return path back to the main part of the home; the required area of the jumper duct is equal to the supply area multiplied by 1.2 OR
    2.3. Transfer grilles sized to provide a return path back to the main part of the home. These can be high -low systems (high on the bedroom side, low on the hallway side) or placed over doors in non-load bearing walls. The grilles are sized by dividing the supply cubic feet per minute by 1.85 to get square inches.

Carbon Monoxide Testing

1. If CO levels are higher than 35 ppm during normal appliance operation, turn off the appliance, ventilate the space, and evacuate the building. The building may be reentered once ambient CO levels have gone below 35 ppm.

2. The appliance must be repaired and the problem corrected prior to completing the combustion safety diagnostics.

3. If there are combustion appliances within the building envelope, a carbon monoxide detector should be installed in the main area of each floor and in the hallway outside each bedroom

Worst Case Depressurization Testing

1. If the results of the Worst Case Depressurization Test indicate the potential for backdrafting, the combustion appliance zone should be isolated by creating a sealed combustion closet containing the combustion appliances that has the proper amount of combustion air supplied to it according to the applicable version of the IRC.
    1.1. If vertical ducts are used to supply combustion air, the openings must provide a free area of 1 square inch per 4,000 Btu/h of the total input rating for all the fuel gas appliances in that chamber.
    1.2. If horizontal ducts are used to supply combustion air, the openings must provide a free area of 1 square inch per 2,000 Btu/h of the total input ratings.
    1.3. If a single opening is used to supply combustion air, it must provide at least 1 square inch of free area per 3,000 Btu/h of the total input ratings AND must be at

least as large as all the vent pipes added together. The size requirement does not change for vertical or horizontal ducting.

2. Standard combustion appliances should be replaced with sealed combustion, direct vent appliances

Informative Appendix E: Tables

(This appendix is not part of this standard. It is informative and does not contain requirements necessary for conformance to the standard.)

Life Expectancy of Equipment

Component	Life Expectancy in years
Dishwasher	9
Clothes Dryer	13
Clothes Washer	10
Electric Water Heater	11
Natural Gas Water Heater	10
Air Conditioner	15
Natural Gas Furnace	18
Electric Furnace	15
Heat Pump	16

Age-Based Default Efficiencies

System, EF	Pre-1960	1960-74	1975-83	1984-87	1988-91	1992-2006
Gas Storage	0.47	0.47	0.49	0.55	0.56	0.56
Electric Storage	0.79	0.80	0.81	0.83	0.87	0.88

Domestic Water Heating Equipment

Systems	Pre-1960	1960-69	1970-74	1975-83	1984-87	1988-91	1992-2006
Furnace, AFUE	0.60	0.60	0.65	0.68	0.68	0.76	0.78
ASHP, HSPF	4.5	4.5	4.7	5.5	6.3	6.8	6.8
Water GSHP, COP	2.7	2.7	2.7	3.0	3.1	3.2	3.5
Earth GSHP, COP	2.3	2.3	2.3	2.5	2.6	2.7	3.0
ASHP, SEER	5.0	6.1	6.5	7.4	8.7	9.4	10.0
Water GSHP, EER	10.0	10.0	10.0	13.0	13.0	14.0	16.0
Earth GSHP, EER	8.0	8.0	8.0	11.0	11.0	12.0	14.0
Central AC, SEER	5.0	6.1	6.5	7.4	8.7	9.4	10.0
Room AC, EER	5.0	6.1	6.1	6.7	7.7	8.1	8.5

HVAC Equipment

Depressurization Limits of Combustion Equipment

Appliance Type	Depressurization Limit
Single atmospherically vented water heater	2 Pascals
Atmospherically vented DWH & furnace	3 Pascals
Atmospherically vented DWH & induced draft furnace	5 Pascals
Single atmospherically vented furnace	5 Pascals
Single induced draft furnace	15 Pascals
Power vented, sealed combustion appliance	> 25 Pascals

Informative Appendix F: Sample Homeowner Interview

(This appendix is not part of this standard. It is informative and does not contain requirements necessary for conformance to the standard.)

Date:		Auditor:	
Address:		Client Name:	
City:		Electric Utility:	
County:	ZIP Code:	Gas Utility:	
Year House Built:		Year Current Occupants moved in:	
Recent Work Performed: Y N		Comfort Complaints: Y N	
What:		Where:	
Own	Rent	Consider Improvements based upon audit findings:	No. Occupants:
Smoke in home:		Unvented combustion appliances in home: Y N Type:	
Yes	No	Yes	No
History of illnesses since moving into home:			
Flu	Headaches	Asthma	How used:
Other:			
Close windows & doors while HVAC on: Y N			
Change HVAC Filter:		Maintenance on HVAC:	
Flush DWH:		Turn off lights & appliances not in use: Y N	
CFL's: Yes No		Use kitchen exhaust while cooking: Y N	
Programmable T-Stat: Y N		Use bath exhaust while bathing/showering: Y N	
Received instruction on operating HVAC system and t-stat: Yes No			
Settings on T-Stat: Heating- Cooling-			
High bill complaints: Yes No		Bills available for review: Y N	
Basement: Yes No		How used:	
Window Condensation: Yes No		Plumbing Leaks: Yes No	
Roof Leaks: Yes No Repaired		Foundation Moisture: Yes No	
Swimming Pool: Yes No	Inside	Outside	Solar cover: Yes No
Hot tub: Yes No	Inside	Outside	When used:
Pump run time:	How heated:	Pool Season:	
Wood burning stove: Yes No		Wood burning fireplace: Yes No	
How used:		How used:	

Informative Appendix G: Sample Scope of Work Form

(This appendix is not part of this standard. It is informative and does not contain requirements necessary for conformance to the standard.)

Scope of Work for _____

All work will be performed according the following checked standards

Standards

International Residential Code for One- and Two-Family Dwellings- 2003, published by the International Code Council, Inc., www.iccsafe.org

International Energy Conservation Code- 2006, published by the International Code Council, Inc., www.iccsafe.org

International Mechanical Code- 2003, published by the International Code Council, Inc, www.iccsafe.org

International Fuel Gas Code- 2003, published by the International Code Council, Inc., www.iccsafe.org

ANSI/ACCA Standard 5 QI-2007 HVAC Quality Installation Specification, published by the Air Conditioning Contractors of America, www.acca.org

Manual J, Residential Load Calculation, 8th edition, published by the Air Conditioning Contractors of America, www.acca.org

Manual D, Residential Duct Systems,3rd edition, published by the Air Conditioning Contractors of America, www.acca.org

Manual S, Residential Equipment Selection, published by the Air Conditioning Contractors of America, www.acca.org

Manual RS, Comfort, Air Quality, & Efficiency by Design, published by the Air Conditioning Contractors of America, www.acca.org

Manual T, Air Distribution Basics, published by the Air Conditioning Contractors ofAmerica, www.acca.org

Manual H, Heat Pump Systems, published by the Air Conditioning Contractors of America, www.acca.org

Manual G, Selection of Distribution Systems, published by the Air Conditioning Contractors of America, www.acca.org

ASHRAE Standard 62.2 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., www.ashrae.org

ASHRAE Standard 52.2 , published by the American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., www.ashrae.org

ASTM Standard C1015-06 “Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation”, published by ASTM International, www.astm.org

ASTM Standard C1320-05 “Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction”, published by ASTM International, www.astm.org

ASTM Standard C727-01 (2007)e1 “Standard Practice for Installation and Use of Reflective Insulation in Building Constructions”, published by ASTM International, www.astm.org

ASTM Standard C1158-05 “Standard Practice for Installation and Use of Radiant Barrier Systems in Building Constructions”, published by ASTM International, www.astm.org

ASTM Standard E2112-07 “Standard Practice for Installation of Exterior Windows, Doors and Skylights”, published by ASTM International, www.astm.org

Flexible Duct Performance and Installation Standards 4th edition, published by the Air Diffusion Council, www.flexibleduct.org

Fibrous Glass Duct Construction Standards, 5th edition, published by the North American Insulation Manufacturers Association, www.naima.org

FTC Trade Regulation Rule 16 CRF 460, Labeling and Advertising of Home Insulation, published by the Federal Trade Commission, www.ftc.gov

Who will perform the work?