RESNET
Residential Energy Services Network
Setting the STANDARD for QUALITY

NATIONAL HOME ENERGY RATING TECHNICAL GUIDELINES

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Appendix A

ON-SITE INSPECTION PROCEDURES FOR MINIMUM RATED FEATURES

Excerpted from: *Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings, Version 2.0*, Home Energy Rating Systems Council (HERSC), August 1996.
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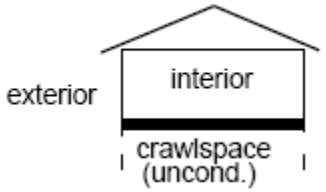
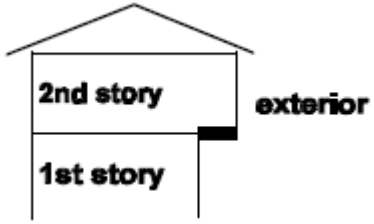
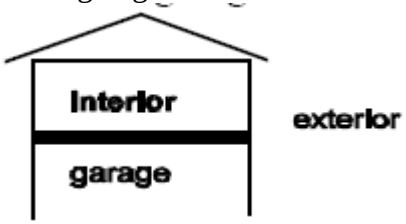
ON-SITE INSPECTION PROCEDURES FOR MINIMUM RATED FEATURES

Building Element: Foundation		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Conditioning of space	Determine whether a crawl space or basement is unconditioned, indirectly conditioned or directly conditioned	To determine whether a crawl space or basement is conditioned, assess the insulation placement in the walls or floor/ceiling assembly. A vented crawl space is considered unconditioned regardless of the location or existence of insulation. This is because the ambient temperature of the crawl space is close to the outdoor ambient temperature.  An unvented crawl space or basement may be considered either unconditioned, indirectly conditioned, or fully conditioned, based on the following criteria: *Unconditioned* -Foundation walls are not insulated, floor/ceiling assembly is insulated, and any heating or plumbing distribution systems in the space is insulated. The intention in an unconditioned crawl space or basement is to minimize the heating system losses into the space by means of the distribution and plumbing insulation, and to minimize heat flow through the insulated floor/ceiling assembly. *Conditioned, indirectly* -Foundation walls are not insulated with floor/ceiling assembly insulated and distribution system in the space uninsulated, or foundation walls insulated with floor ceiling assembly insulated or non-insulated and distribution system uninsulated. In an indirectly conditioned crawl space or basement, heating or cooling is unintentionally delivered to the space either through the floor/ceiling assembly or by unintentional losses

		from the heating/cooling system. Indirectly conditioned spaces are typically between the temperature of the outdoor ambient temperature and the indoor conditioned space temperature.

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Conditioning of space (continued)	Determine whether a crawl space or basement is unconditioned, indirectly conditioned or directly conditioned (continued)	*Conditioned, directly* -Foundation walls insulated or uninsulated and basement or crawl space is intentionally or unintentionally conditioned, by means of a forced air heating or cooling system, hydronic heat, electric resistance, etc. Fully conditioned spaces are typically maintained at the same temperature as the above grade spaces. The distinction between indirectly and directly conditioned basement spaces may be difficult, but is important from a heat transfer perspective. Rater judgment will have to be utilized in many cases. Interview the owner about the temperature in the basement during the heating season, and assess the potential for standby loss from the heating equipment and distribution system, e.g., jacket insulation, leakiness of ducts, insulation on distribution systems, etc.
Construction type	Identify floor over crawl space	A crawl space is typically defined as a foundation condition with a clear vertical dimension 4 feet high or less. Crawl spaces may be vented or unvented. Vented crawl spaces have some form of vent or louver in the crawl space walls, or are constructed in such a manner so that air moves freely from outside the walls to inside the crawl space. Unvented crawl spaces are constructed without any form of vents or louvers in the wall, and are constructed to exclude, to the greatest extent possible, air leakage from outside the walls to inside the crawl space. Crawl spaces may be accessed by a hatchway in the floor of the house or in the wall of the crawl space. To identify a crawl space, look for foundation vents and/or stairs leading up to floor levels from the outside of the building.
	Identify floor over full basement	A full basement has characteristics similar to an unvented crawl space, except that the clear vertical dimension is typically greater than 4 feet. Stairs that lead from the main floor to a below grade space are an indication of a basement in a house, although a house may have a basement with access similar to a crawl space access.

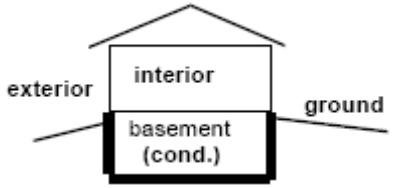
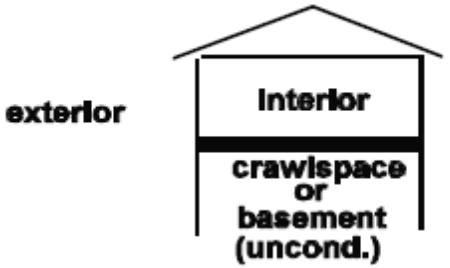
	Identify floor over exterior space	Floor area that borders exterior unenclosed space above grade is considered floor to exterior. For example, in a two story house, the second story may extend horizontally further than the first story, creating some floor area that is exposed to the exterior. 

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
	Identify floor over unconditioned garage	Identify floors over an unconditioned garage. 
	Identify slab on grade foundation	A slab on grade can be recognized by the absence of either a crawl space or basement. A slab on grade is constructed by pouring a concrete slab directly on the ground as the floor for the house. 
	Identify walkout basement	A walkout basement, if fully conditioned, is typically considered partially slab on grade

		construction (where the floor level is above grade) and partially a basement (where the floor level is below grade).
Interior surface condition	Determine the inside surface condition of floor (exposed or covered)	*Covered* -If floor is covered with wall-to-wall carpet, consider it covered. Floors with only area rugs are not considered covered. *Exposed* -If the floor has tile, linoleum or wood, consider it exposed.

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Surface area	Measure floor dimensions	Measure floor dimensions in accordance with ANSI Z765-1996 with the exception of Section 3 Paragraph 6 (floor areas with ceiling heights of less than 5' will be included in finished square footage). For conditioned basements and crawl spaces, find dimensions of basement walls and floor. Divide walls into above and below grade sections. Measure the house or assembly element (window, wall, ceiling, etc.) to the nearest inch, and record the square footage to the nearest square foot. Use exterior measurements; those measurements should start at the exterior finished surface of the outside wall. Openings to the floor below should not be included in the square footage calculation, with the exception of stairways; stairways and associated landings are counted as square footage on both the starting and ending levels. Do not include the "footprint" of protruding chimneys or bay windows. Do include the "footprint" of other protrusions like a cantilever when it includes finished floor area. Do include the square footage of separate finished areas that are connected to the main body of the house by conditioned hallways or stairways. Note to divide basement and crawl space walls into above and below grade.
Thermal mass	Determine presence of thermal mass	Concrete slabs and basement walls when uninsulated or insulated on the exterior can be considered as thermal storage mass when combined with solar gain from south fenestration. Note type of thermal mass: concrete, brick, tile, water.

		South fenestration is defined as fenestration oriented between 45E SE to 45E SW. Slab-on-grade construction in climates with more than 3600 HDD (65) may not be considered solar storage mass unless properly insulated (edge, perimeter, or under slab).

Building Element: Floor of conditioned basement or crawl space		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation	Determine insulation in walls and floor of conditioned basement or crawl space	If basement or crawl space is determined to be fully conditioned, its walls and floor are considered part of the building envelope. (The floor between the house's ground floor and the basement or crawl space is considered an interior boundary with no associated heat transfer calculated.)  Determine insulation type, thickness and R-value in walls. Wall insulation may be located inside foundation wall (studs and batts, foam under drywall, etc.), integral with foundation wall (insulated cores of block wall, insulating concrete block such as insulating formwork) or outside the foundation wall (rigid foam insulation).
Insulation	Determine amount of floor insulation	

		Use the inspection guidelines under "Walls—Insulation value" to assess "Grade I", "Grade II", or "Grade III" installation. Note: in addition to the inspection guidelines under "Walls", "Grade I" installation for floor insulation also requires that the insulation be installed in complete contact with the subfloor surfaces it is intended to insulate. For loose fill applications, multiply the thickness of the insulation (in inches) by the appropriate R-value per inch based on the insulation type in order to calculate the total existing floor insulation R-value. Floor insulation over unconditioned basements or enclosed (vented or unvented) crawlspaces need not be enclosed to attain a "Grade II" or "Grade I" assessment; floor insulation over ambient conditions does.

Building Element: Slab-on-grade		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Perimeter	Determine perimeter of slab foundation	Determine the perimeter of the slab foundation by measuring each dimension to the nearest ½ foot and adding them together.
Insulation	Determine if slab perimeter insulation exists	If present, slab perimeter insulation is usually installed on the outside of the slab and extends both above and below grade. To identify slab perimeter insulation, look for a protective coating above grade as opposed to the usual exposed slab edge at any conditioned space(s). Move a little bit of dirt away from an edge of the slab where conditioned space is located. If present, the rigid insulation around the perimeter of the slab may be seen. However, it may be difficult to visually verify the existence of slab perimeter insulation because of the protective covering which may be installed over the rigid insulation. Slab insulation may also occur between the foundation wall and the slab itself, although this is harder to assess and verify. If the floor has carpeting, a sharp needle may be poked through the carpet near the baseboard on an outside wall. If the needle penetrates beyond the depth of the carpet, there is probably foam insulation between the slab and foundation wall.

		Under slab insulation cannot be assumed to exist unless visually verified by a photograph of construction, at chase way, at sump opening or at plumbing penetrations.

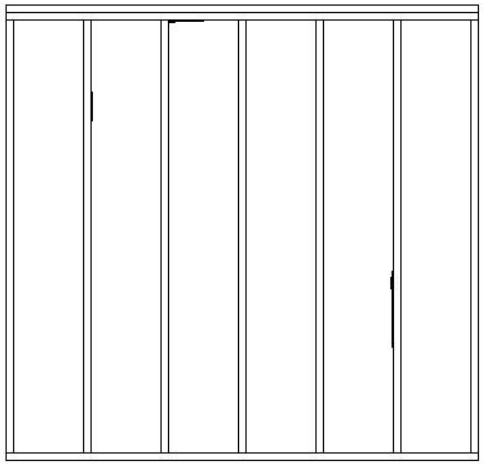
Building Element: Walls		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Color	Determine the color of the wall	Identify the color of the wall as light, medium, or dark.
Construction type	Determine the structural system of walls	*Wood framing* -is very common in residential construction. Wood studs are located 16" or 24" on center all along the wall. Knocking on the wall will give a "hollow" sound in the cavities between the studs and a "solid" sound at the stud locations. *Metal framing* -can be found in some newer residential construction. A strong magnet slid against the wall will hold to metal framing. Also check inside the attic at the edges for evidence of metal wall framing. *Masonry walls* - include walls constructed of concrete or brick. A wood framed wall with brick veneer would not be considered a masonry wall. Also note the siding or finish material on the wall. *Foam core walls* - are a sandwich panel consisting of a foam center with outer layers of structural sheathing, gypsum board or outer finish materials. Foam core panels may be structural (load bearing) or non-structural. Non-structural panels are frequently used in post and beam construction. *Log walls* - are typically solid wood walls, using either milled or rough logs or solid timbers. Some homes may have the appearance of solid log walls, yet may actually be wood frame walls with siding that looks like solid logs inside and out. Some log walls are manufactured with insulated cores. Unless manufacturer's documentation is available or visual inspection of insulation type and thickness can be made, assume no added insulation exists in a log wall.

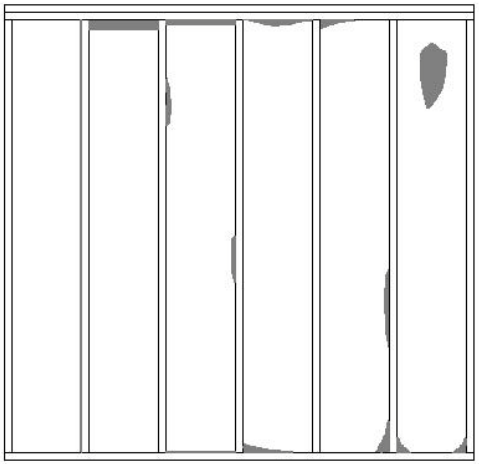
Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Framing members	Determine framing member size for all framed walls exposed to unconditioned space	To determine whether 2x4 or 2x6 framing exists: Measure the width of the window jambs; Subtract the widths of the wall coverings and sheathing materials (approximately .25" to 1.0" for stucco, .5" to .6" for interior sheetrock, and .5" to .75" for other exterior siding materials); Compare the remaining width to 3.5" for a 2x4 wall or 5.5" for a 2x6 wall; If exposed garage walls exist, examine them for reference (although they will not *always* be the same as other walls); If a wall does not come close to the framing width of a 2x4 or 2x6, inspect for foam sheathing on the inside or outside of the walls. In superinsulated construction, "double stud" or "strapped" walls may account for thickness greater than 5.5". For brick veneer walls, assume 4.5" - 5" for brick, airspace and sheathing material. Check the framing member size on all sides of the house. If an addition has been added, be sure to check the walls of the addition separately. If the house has more than one story, check the framing member size for each floor.

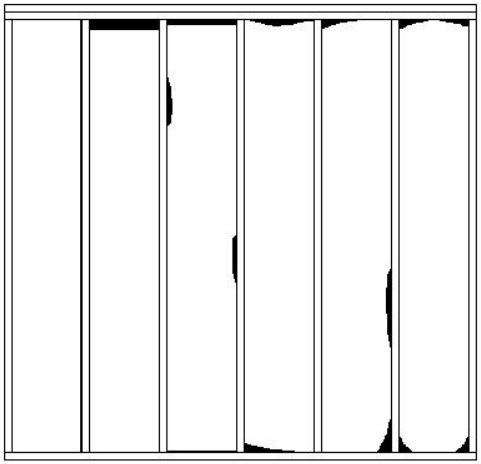
Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation value	Determine type and thickness of existing	Framed Walls Check at plumbing outlet under sink or, in order of preference, remove cable outlet plate,

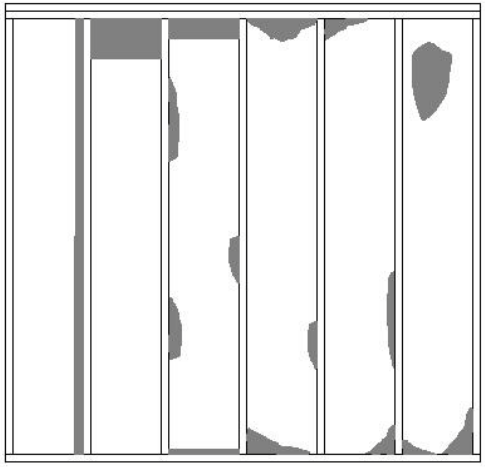
	insulation and resultant R-value	telephone plate, electrical switch plates and/or electrical outlet plates on exterior walls. Probe the cavity around the exposed plate with a non-metal device (such as a plastic crochet hook or wooden skewer). Determine type of insulation (fiberglass, cellulose insulation, foam, etc.). Inspect outlets/switch plates on each side of the house to verify that all walls are insulated. Multiply the wall framing member size (in inches) by the R-value per inch. Be sure to use the actual thickness of the insulation when calculating the total insulation R-values. Use 3.5" for 2 x 4 walls and 5.5" for 2 x 6 walls constructed after 1945. Parts of the house that were added later must be checked separately from the original walls. <u>Sheathing</u> Insulated sheathing may exist on walls, but can be difficult to verify. Walls with insulated sheathing may be thicker than walls without insulated sheathing. Visual verification of insulated sheathing may be found in the attic at the top of the wall, exterior wall penetrations, and at the connection between the foundation and the wall.

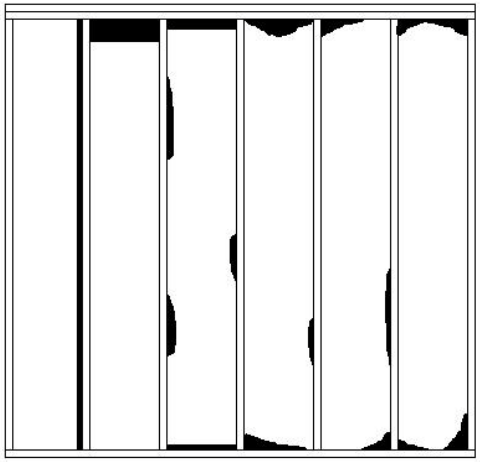
Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation Installation	Determine cavity insulation installation characteristics	When it is possible to inspect insulation as installed (i.e., new construction), inspectors shall rate the installation as “Grade I, II, or III” according to the following guidelines, regardless of insulation material or installation process. Note that all insulation installation techniques require proper care to ensure they are completed correctly; if they are not, thermal performance can suffer dramatically. These guidelines apply to cavity fill insulation, continuous rigid insulation, and any other field-installed insulation products. 1. "Grade I" shall be used to describe insulation that is generally installed according to manufacturers instructions and/or industry standards. A "Grade I" installation requires that the insulation material uniformly fills each cavity side-to-side and top-to-bottom, without substantial gaps or voids around obstructions (such as blocking or bridging), and is split, installed, and/or fitted tightly around wiring and other services in the cavity. To inspect, probe in, around, or through the insulation and/or vapor retarder in several places to see whether these requirements are met. Replace or repair the vapor retarder and insulation as necessary. During inspection (typically before drywall is installed), if the exterior sheathing is visible from the building interior through gaps in the cavity insulation material, it is not considered a “Grade I” installation. To attain a rating of "Grade I", wall insulation shall be enclosed on all six sides, and shall be in substantial contact with the sheathing material on at least one side (interior or exterior) of the cavity. Exception: the interior sheathing/enclosure material is optional in climate zones 1-3, provided insulation is adequately supported and meets all other requirements. For rim or band joist insulation, use the inspection guidelines under “Walls—Insulation value” to assess “Grade I”, “Grade II”, or “Grade III” installation. Exception: the interior sheathing/enclosure material is optional in all climate zones, provided insulation is adequately supported and meets all other requirements.

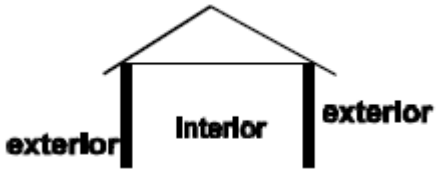
		For exterior applications of rigid insulation, insulation shall be in firm contact with the structural sheathing materials, and tightly fitted at joints to be considered a “Grade I” installation. For faced batt insulation, Grade I can be designated for side-stapled tabs, provided the tabs are stapled neatly (no buckling), and provided the batt is only compressed at the edges of each cavity, to the depth of the tab itself, and provided it meets the other requirements of Grade I. For sprayed or blown-in products, density shall be sufficient that the fill material springs back when compressed slightly with a hand or finger, and provided it meets the other requirements of Grade Interpretation: The following illustrations represent the boundary conditions between Grade I and Grade II, that is, the installation shall be at least this good to be labeled as “Grade I”:  Occasional very small gaps are acceptable for “Grade I”.

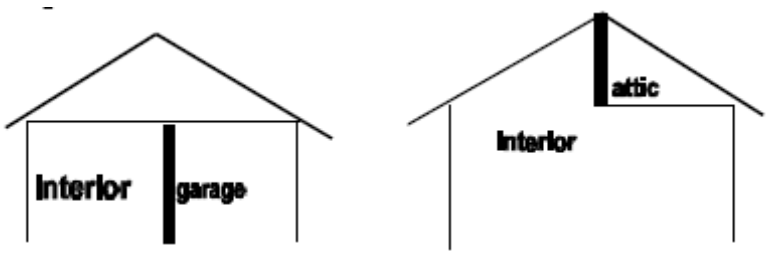
		 Compression or incomplete fill amounting to 2% or less, if the empty spaces are less than 30% of the intended fill thickness, are acceptable for “Grade I”. The following standards may be applied as a reference: NAIMA, Recommendations for Installation in Residential and Other Light-Frame Construction—Fiber Glass Home Insulation (PUB # BI402), Recommendations for Installation in Residential and Other Light-Frame Construction—Fiber Glass Loose Fill Insulation (PUB # BI403), CIMA, Technical Bulletin #2 -- Standard Practice for Installing Cellulose Building Insulation, Technical Bulletin #3-- Standard Practice for Installation of Sprayed Cellulosic Wall Cavity Insulation. For other products and materials, manufacturer's installation instructions will apply. 2. "Grade II" shall be used to describe an installation with moderate to frequent installation defects: gaps around wiring, electrical outlets, plumbing and other intrusions; rounded edges or “shoulders”; or incomplete fill amounting to less than 10% of the area with 70% or more of the intended thickness (i.e., 30% compressed); or gaps and spaces running clear through the insulation amounting to no more than 2% of the total surface area covered by the insulation. To attain a rating of "Grade II", wall

		insulation shall be enclosed on all six sides, and shall be in substantial contact with the sheathing material on at least one side (interior or exterior) of the cavity. Interpretation: The following illustrations represent the boundary conditions between Grade II and Grade III, that is, the installation shall be at least this good to be labeled as “Grade II”:  No more than 2% of surface area of insulation missing is acceptable for “Grade II”

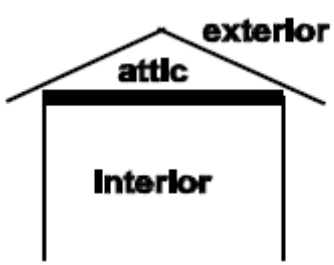
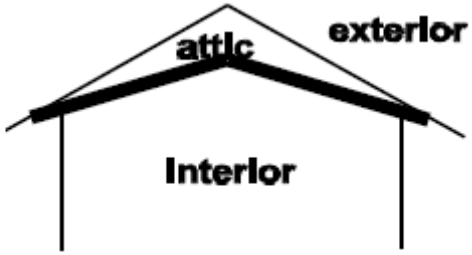
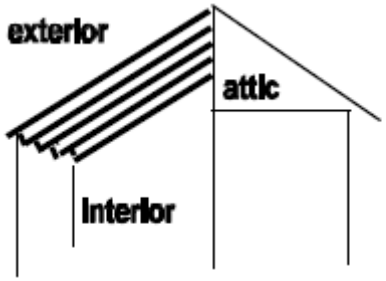
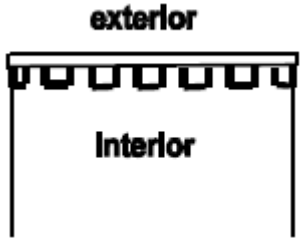
		 No more than 10% of surface area of insulation compressed or incomplete fill, by up to 30% (70% or more of intended thickness) is acceptable for “Grade II”. 3. "Grade III" shall be used to describe an installation with substantial gaps and voids, with missing insulation amounting to greater than 2% of the area, but less than 5% of the surface area is intended to occupy. More than 5% missing insulation shall be measured and modeled as separate, uninsulated surfaces according to 3.B.5.p. This designation shall include wall insulation that is not in substantial contact with the sheathing on at least one side of the cavity, or wall insulation in a wall that is open (unsheathed) on one side and exposed to the exterior, ambient conditions or a vented attic or crawlspace. The presence of an air-impermeable barrier such as housewrap will be considered to enclose the building cavities. Interpretation: The following illustration represents the boundary conditions between Grade III and the situation whereby one must measure the uninsulated areas; that is, the installation shall be at least this good to be labeled as “Grade III”:

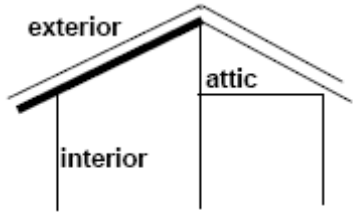
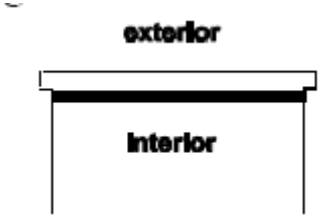
		

Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Location	Determine whether walls border exterior space, attic, garage or crawl space	*Wall to exterior* -Walls border exterior space.  *Wall to enclosed unconditioned space* -Walls that border unconditioned attics, garages and crawl spaces.

		
Surface area	Determine surface area of all walls exposed to unconditioned space	Measure linear perimeter of the walls to the nearest ½ foot. Measure the interior wall height of the walls to the nearest 1/4 foot. Use these measurements to calculate surface area.
Thermal mass	Determine type and thickness of all mass walls	If the dwelling's walls are constructed of concrete, masonry or brick, determine their type and thickness. <u>Solid concrete walls (poured)</u> Measure the thickness of the poured concrete wall in inches. <u>Concrete Masonry Unit</u> Cinder block or uninsulated concrete wall - hollow in the middle. May contain vermiculite or perlite insulation. Check for additional insulation (interior furring, foam board, foam fill). Measure the thickness of the wall in inches.

Building Element: Roof/Ceiling		
Rated Feature	**Task**	**On-Site Inspection Protocol**
All ceiling areas between conditioned and unconditioned space	Obtain measurements of all ceiling areas	Measure the linear perimeter of the ceiling area to the nearest ½ foot and use these measurements to calculate surface area of the ceiling. If a ceiling area is vaulted, it may be necessary to calculate dimensions geometrically.

		Identify the ceiling as one of the following types. <u>Ceiling to attic</u> If the ceiling has attic space above (even if the ceiling is vaulted, as in a scissor truss) it is considered ceiling to attic. If there is a vaulted ceiling check it's angle against the angle of the roof -- if the ceiling angle is gentler there is attic space above the ceiling. Also check for an attic access, either separate or from an attic over another part of the house.   Framed ceilings fall into two categories: *Roof on exposed beams or rafters* - when you look up from inside the room, you will see exposed beams or rafters.  

Building Element: Roof/Ceiling (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
All ceiling areas between conditioned and unconditioned space (continued)	Determine ceiling construction type (continued)	*Finished framed ceiling* -if the ceiling is framed (has no attic space above it, but you cannot see the rafters because the ceiling is finished with drywall, plaster, paneling, etc.) consider it a finished framed ceiling.  
	Determine the size of the framing members for framed ceilings	Determine the framing member size for framed ceilings exposed to unconditioned spaces. Check the framing by looking for an access through an attic over another part of the house or by looking at the rafters from the outside.
Color	Determine the color of the roof	Identify the color of the roof as light, medium or dark. Also check for a special reflective roof coating.
Construction type	Determine the roof's construction type	Identify the type of roofing surface. Some common types include: Asphalt shingle; Pebble/gravel built-up roof; Tile roof; Wood shingle roof; Rubber roof/roof coating; Metal.
Insulation value	Determine R-value of insulation in attic	Measure the average depth in four places.

Building Element: Ceiling (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation value	Determine R-value of insulation in attic	Use the inspection guidelines under "Walls—Insulation value" to assess "Grade I", "Grade II", or "Grade III" installation. Note: in addition to the inspection guidelines under "Walls", "Grade I" installation for ceiling insulation also requires that the insulation be installed in complete contact with the drywall or sheathing surfaces it is intended to insulate. For loose fill applications, be sure to get four readings which accurately reflect the insulation level (the depth should be representative of the entire attic area being examined). Multiply the minimum depth of insulation by its R-value per inch to obtain the total R-value. Insulation in ceilings with attic above need not be enclosed to attain a "Grade II" or "Grade I" assessment. For sealed, unvented attic/roof assemblies, the interior sheathing/enclosure material is optional in climate zones 1-3, provided insulation is adequately supported and meets all other requirements, including full contact with the exterior (roof) sheathing. For ceiling insulation, eave baffles or equivalent construction is required to prevent wind washing to be considered "Grade I". Note whether the cavity insulation leaves the framing elements exposed, or covers them; if covered, note the thickness that covers the framing.
	Determine the R-value of insulation in framed ceiling	Determine the insulation R-value which exists in the ceiling area (cavity). Use the following method for calculating the overall ceiling R-value: • Determine the type of ceiling insulation present (may be a combination of more than one type); • Multiply the R-value of the material by the depth of the insulation; • If there is no access to the framed ceiling, ask the customer for documentation of insulation or use a default value based on age.

Building Element: Roof Ceiling (Continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation value	Determine insulation value	The rim joist is the band joist around the perimeter of the floor joists over a basement or crawl space, or between 2 stories of a house. <u>Crawl space or Basement</u> From the basement or crawl space, visually identify and measure the depth of insulation at the rim joist. The insulation used is generally fiberglass batts, often folded in an L-shape and attached to the rim joist. Rigid board insulation may also be found.
Insulation value (continued)	Determine insulation value (continued)	<u>Between Stories</u> Look for access to the area from a garage or a utility access trap door. Visually identify and measure insulation if it exists. If no access can be found, assume insulation exists at the rim joist between stories if: • Insulation was found at the rim joist at the top of the crawl space or basement in the same house; or • Insulation is found in the walls of the same house. Otherwise, assume no rim joist insulation exists.

Building Element: Doors		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Construction type	Determine construction type of doors	Determine if the exterior door(s) is fiberglass, metal, or wood by making a close inspection of its texture, distinguishing the sound produced when knocking on it, and checking its side view.
Insulation	Determine whether doors are insulated	Judge whether the exterior door(s) is insulated (or not) by its sound, temperature transfer, labeling, or thermal break. *Sound* - Insulated/solid door will sound dull when knocked on. An uninsulated/hollow door

		will sound hollow. *Heat transfer* - Feel the inside and outside of the door with flat palms. Insulated/solid door will less readily transfer heat. The inside will feel warmer in cold outside weather and cooler in hot outside weather than an uninsulated/hollow door.
Insulation (continued)	Determine whether doors are insulated (continued)	*Labeling* - Check the side view of the door at the hinges for a descriptive label. *Thermal break* - Check the side view of metal doors for thermal breaks.
Surface area	Determine surface area of doors	Measure the surface area of the door(s) to the nearest ½ square foot.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Area	Determine area of windows	Measure the area of the window openings using width times height to the nearest inch. Window openings are measured from the outside edge of the framing and include the frame width.

Building Element: Windows (continued)		
Construction type	Determine window framing and glazing characteristics	<u>Framing Type</u> Examine each window frame in order to determine the type of material used. Open the window and examine it to see whether the frame is made of metal, wood, or vinyl. Tap the frame with fingernail or knuckle to test if it's vinyl or metal. Wood frames are usually thicker than metal. If the window is dual-pane or multiple-pane and is metal framed, determine if a thermal break is present by looking for two separated metal extrusions connected by a rubber spacer. Ask the customer for documentation if you can't tell.

		Some wood windows may have vinyl or aluminum cladding. Check both the inside and outside, since some windows will have vinyl cladding on one side only. <u>Glazing Type</u> Check all windows in the house for number of panes and existence of tint and/or low-e coating. To determine whether the windows are single-paned or multiple-paned: • Look at frame width and spacers; • Look at reflections; • Look at edge thickness. To determine if glazing has a tint or low-e coating: • Check the customer's product literature if available; • Perform a "match test" - there should be one reflection per pane or coating, including low-e and tinting (e.g., a double-paned window with low-e and tint should show 4 reflections); • Compare to glazing samples with and without tinting; • Compare the windows within the space, since tinting is often applied only to certain windows in a house; • Look for a low-e label or etching on the glass.
Orientation	Determine orientation of all windows	Use a compass (adjusting for magnetic deviation) to determine orientation of all windows.
Building Element: Windows (continued)		
Shading	Determine shading of windows	Identify shading by external shade screens, house overhangs/awnings, and shade from trees and other buildings. <u>External Shade Screens</u>

		The most common screen is an insect screen that covers some or all of the window. If it is a full-coverage type screen, assume it is a shade screen. Compare samples of the screen's mesh pattern to those of a window screen sample to determine the type and shading coefficient of the screen. Ask customer for documentation for the shading coefficient (SC) of the screen. If you cannot determine the shading coefficient of the screen, use 36% SC as a default. <u>Projection (Overhang)</u> The shading impact of an overhang can be found by measuring the distance of the projection from the exterior wall surface and the distance (height) between the top of the window and the bottom edge of the overhang. Measure the length of the overhangs over each exterior wall. Measure the height above the window to the bottom edge of the overhang. <u>Exterior Shading</u> *Full (40% SC)* -Consider a 40% SC for an entire side of a house as being roughly equivalent to having a shade screen over a window. For trees and/or bushes to equal this effect, there should be a very dense amount of trees and/or bushes along the entire side of the house that shade both its vertical and horizontal surfaces almost totally. *Partial (70% SC)* -Based on the above definition for full shading, partial shading is considered to be anything in between full and none (no shading). *None (100% SC)* - No shading indicates there may be small plants or shrubs only,

Building Element: Windows (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Solar heat gain factor	Determine solar heat gain factor of glazing	Check product information and consult NFRC guide.
U-value	Determine window U-value	Look for an NFRC label on new windows (it will display full window U-value). If no label can be found but customer has documentation, look up product information in NFRC Certified Products Directory to determine U-value, or consult manufacturer's literature.

Building Element: Skylights		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Area	Determine area of skylights	See windows.
Construction type	Determine framing and glazing characteristics of skylights	See windows.
Orientation	Determine orientation of skylights.	Determine the orientation of the lower edge of the skylight. Use this direction as the orientation of the skylight.
Shading	Determine shading of skylights	See windows.
Solar heat gain coefficient	Determine solar heat gain coefficient of skylights	See windows.
Tilt	Determine tilt of skylights	Measure the tilt of the skylight relative to horizontal. This can be done with a level and angle finder instrument, or geometrically with a protractor (from the ceiling length and heights).
U-value	Determine skylight U-value	See windows.

Building Element: Air leakage		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Blower door test	Determine effective leakage area from a blower door test	Use the testing protocol described in ASHRAE Standard 119 Section 5.1, with the modifications described below: The following protocol shall be followed in preparing the building envelope for testing: 1. Leave all supply registers and return grills open and uncovered. 2. Leave all bathroom and kitchen fans open (i.e., in their normal operating condition). Only a permanently installed back draft damper in its normal condition may impede the flow of air. 3. Leave any combustion air ducts or louvers to the exterior open. (If a homeowner or builder has sealed them off, open them for the test.) 4. Leave any make-up air ducts with in-line dampers (e.g., for large kitchen exhaust fans or combustion air) as-is (unsealed). Only a permanently installed back draft damper or motorized damper, in its normal condition may impede the flow of air. 5. Leave the dryer vent as-is, whether or not the dryer is in place during the test. Only a permanently installed back draft damper in its normal condition may impede the flow of air. 6. Leave open any outside air duct supplying fresh air for intermittent ventilation systems (including a central-fan-integrated distribution system) 7. Operable crawl-space vents, where present, are to be left in the open position. 8. Open all interior doors within the conditioned space, including doors to conditioned basements. (Closet doors may be left closed unless the closet contains windows or access to the attic or crawl space). 9. Leave louvered openings of a whole-house fan as is. (If there is a seasonal cover in place during the test, leave it in place.) 10. Close all doors to the exterior or unconditioned spaces; if any door to the exterior or unconditioned space lacks weather-stripping at testing time, it can be temporarily

		taped off. 11. Close and latch all windows. 12. Close chimney dampers. 13. Either seal or fill with water plumbing drains with p-traps that may be empty. 14. Seal off exterior duct openings to *continuously operating* fresh-air or exhaust-air ventilation systems (preferably at the exterior envelope). 15. Close any adjustable window trickle ventilators and/or adjustable through-the-wall vents. 16. If an evaporative cooler has been supplied with a device used to seal openings to the exterior during the winter, that device should be installed for the test. Use the testing protocol described in ASHRAE Standard 119 Section 5.1. Blower door and associated pressure testing instruments, which include but are not limited to hoses, and Manometers, gauges and fans shall be field tested annually for calibration by the HERS provider or rater. The provider shall use a standard for field testing of calibration provided by the equipment manufacturer. Magnehelic Gauges cannot be field tested and shall be recalibrated by the Blower Door manufacturer annually. Field check the fan and flow measuring systems for defects and maintain them according to manufacturers recommendations The HERS provider shall maintain a written log of the annual calibration check to verify all equipment accuracy for a period of three (3) years. These records shall be made available within 24 hours to a RESNET Quality Assurance Committee member upon request. It is recommended all pressure equipment be field checked for calibration more frequently than is required in these standards, i.e., monthly, quarterly, etc.
Conditioned volume of space	Determine conditioned volume of space	Determine conditioned and indirectly conditioned volume of space by multiplying conditioned floor area by ceiling height. The house may need to be split into different spaces with different ceiling heights and added to each other for both conditioned and indirectly conditioned spaces. For areas with vaulted ceilings, volume must be calculated geometrically.

Estimate	If diagnostic equipment is not used, determine window type and distribution system to estimate leakage	To be determined.
Tracer gas test		To be determined.

Building Element: Heating & Cooling/Distribution System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Air leakage (ducts)	Determine air leakage from ducts	The application of ASHRAE Standard 152 for testing of ducted distribution systems shall be implemented with the following additions and exceptions: 1. Air Handler Fan Flow Measurement using either of the methods specified in Annex A of the standard is preferred. If such measurement is not made, default values of 275 CFM per 12,000 btu/hour of nominal HVAC capacity shall be used. For fossil-fired furnace systems, a default value of 200 CFM for every 12,000 btu/hour of nominal furnace capacity shall be used for heating. 2. Supply and return leakage may be determined by measuring the leakage of each side as in Annex B, or as an alternate the leakage of the entire system may be measured, with the duct pressurization device in the return and the duct-pressure probe in the supply side. The ratio of supply side leakage to return side leakage Q25,s to Q25,r shall be selected separately for heating and cooling based on a worst case determination. The supply side of the system shall be assigned 67% of the leakage and the return shall be assigned 33%, and the overall distribution efficiency determined; then the efficiency with the reverse conditions (67% return and 33% supply) shall be determined, and the lower of the two efficiencies will be applied. 3. Total leakage (Annex C) . The limitation of applicability of Annex C (Section C1) to leakage measurement of 10% or less of air handler air flow shall be based on tested air flow or default air flow, as appropriate according to (1) above. The calculations of 2.5% of air flow in Section C1.1,2, and 3 shall use tested air flow,

		or nominal air flow of 400 CFM per ton. If the register grilles are not installed during the test (C1.2), the 2.5% of fan flow added to the measured leakage may be waived, on condition that a visual inspection, verifying effective sealing of register boot-to-drywall and/or boot-to-subfloor connections, is conducted prior to issuing the final rating.
Insulation	Determine the value of distribution system insulation	Air ducts may be insulated with insulation blankets or rigid insulation board. Inspect the duct or pipe insulation for R-value labeling (printed on the insulation by the manufacturer). If the insulation is not marked with the R-value, identify type and measure the thickness of the insulation to determine R-value. Check for internal insulation by tapping on the exterior and listening to the sound.
Location of air ducts	Determine the location of ducts	Air ducts may be located in the attic, crawl space, basement or in a conditioned area. You must locate and differentiate between supply and return ducts. Ducts may be located in more than one area (e.g., some return ducts in attic and some in conditioned space, etc.).
Type	Identify type of distribution system used to provide space heating and cooling	*Forced air* - a central fan unit connected to ducts which supply heated or cooled air to each room in the home. Forced air systems have supply and return duct work. Supply ducts typically run to each room; return duct work may come from each room or from one or more central locations in the home. *Forced hot water* - heated water is pumped through a series of radiator elements to supply heat. The radiator elements may be conventional radiators, baseboard "fin tube" radiators, cast iron baseboards or radiant hot water panels located at the baseboards or on walls or ceilings. *Hot water radiant system* - heated water is circulated through plastic or metal tubing which is installed in a concrete slab or finished floor or, occasionally, in walls or ceilings. *Unit heater/air conditioner* - heating or cooling is supplied directly from a heating or cooling device located within the space it serves. Window air conditioners and through-the-wall heaters are common examples. Unitary equipment typically has no distribution system.

Building Element: Heating & Cooling/Distribution System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Type (continued)	Identify type of distribution system used to provide space heating and cooling (continued)	*Steam heating* - steam systems utilize a distribution system with cast iron radiators connected to a boiler that creates steam. The steam rises into the radiators through one set of pipes, condenses into water, and drains back to the boiler through another set of pipes. *Electric radiant system* - electric cables are installed in concrete floor slabs or in the ceiling. Electric current is passed through the cables, causing them to heat up, heating the floor or ceiling assembly which radiates the heat to the space. Electric radiant systems may also be comprised of individual radiant panels mounted on the walls or ceilings. *Baseboard electric resistance* - electric elements are installed in baseboard enclosures. Electric current is passed through the electric element to provide heat to the space.

Building Element: Heating and Cooling/Energy Source		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Fuel type	Determine fuels used for heating and cooling	Heating systems may use natural gas, propane, oil, electricity, or some other fuel. Typically the homeowner will know what type of heating fuel is used. Cooling is typically driven by electricity, however some cooling equipment may use natural gas or propane. Look for electric cables and dedicated fuses or circuit breakers for the cooling equipment or gas lines running to the equipment. Note that gas equipment will also have electric cables to power some of the components. Be sure to distinguish between refrigerant lines and possible gas supply lines. *Oil* - look for a large storage tank (typically oblong-shaped) or fill pipes which would indicate a buried tank. Oil is typically supplied to the heating equipment via a 1/4" - 3/8" copper line. A fuel filter may be evident in the line. *Natural gas* - look for a meter connected to piping on the exterior of the home. Piping to the heating equipment is typically done with ½" - 1" iron piping. *Propane* - look for storage tank(s) (typically cylindrical-shaped). Large tanks may be buried with a 12" - 18" cap exposed above grade. Fuel is typically supplied to equipment through 1/4" - 3/8" diameter copper piping. *Electric* - look for large gauge cables running to a central piece of equipment or look at circuit breaker panel for circuits marked for resistance heat circuits (electric resistance or electric radiant systems). *Other fuels* - include coal, wood, processed wood pellets, or other combustible products.

Building Element: Heating and Cooling/Equipment		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Control system	Identify the control system for the heating and cooling system(s)	Determine the type of control systems. There may be separate controls for the heating and cooling systems. Thermostat controls may be programmable. Note types of features available and/or utilized.
Efficiency	Determine the heating and cooling equipment efficiency	Check nameplate for efficiency rating. If the nameplate is missing, use appropriate directories to determine an appropriate default value. SEER is used to measure the efficiency of central air conditioning and air source heat pump systems. AFUE is used to measure the efficiency of furnaces and boilers. EER is used to determine the efficiency of room air conditioners and ground source heat pumps. Check nameplate for SEER or AFUE rating. EER can be calculated from nameplate information by dividing btu output by watt input.

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type	Identify type(s) of equipment for heating and/or cooling	*Furnace* - comprised of a combustion chamber and heat exchanger (natural gas, propane or oil) or an electric resistance element (electric) and a fan which forces air across the heat exchanger or resistance element to provide heat in a forced air system. *Fan coil unit* - hot water from a boiler, domestic water heater, or heat pump is circulated through a coil. A fan blows air over the coil to provide heating. This device is used in a forced air system. *Boiler* - this device creates hot water or steam, and can be powered by any fuel type. Can be used with forced air (in conjunction with a fan coil unit), forced hot water, steam, or hot water

		radiant slab systems. *Split system central air source heat pump* - these systems move energy from one location to another using the vapor compression cycle. They are electrically driven, and can provide heating in winter and cooling in summer by reversing the direction of heat flow. Split system heat pumps consist of an outdoor unit and an indoor air handling unit, resembling a furnace. These systems require ductwork for air distribution. Most air source heat pumps incorporate electric resistance supplemental heat in the indoor section. However, some heat pump systems use fossil fuel furnace for supplemental heating. These are known as "dual fuel" or add-on systems. *Single package central air source heat pump* - a single package central heat pump is similar to a split system, except it combines the functions of the indoor and outdoor units into one cabinet, usually mounted on the roof or on the ground. It also requires a separate distribution system. These are uncommon in single-family residences, however they are sometimes found in multi-family dwellings.

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type (continued)	Identify type(s) of equipment for heating and/or cooling (continued)	*Ground source heat pumps* - are coupled to the ground through the use of a water well sometimes the same well as used for domestic water (known as "open loop" which water or a water/antifreeze mixture is circulated (known as "closed loop"). Look for 3/4" or larger diameter piping going to and from the heat pump. Circulating pumps may be installed in this piping (closed loop systems) or the pump for the water well may be used for circulating water through the heat pump (open loop). The same piece of equipment can be used in either open or closed loop applications, however given the same piece of equipment, closed loop applications typically have lower efficiency ratings than open loop applications. Ground source heat pumps can also utilize a direct expansion of the refrigerant with copper piping

		buried in the ground. Look for 0.25" - 0.50" copper piping leading from the unit to the outdoors with no outdoor unit. *Split system central air conditioner* - similar to a split system air source heat pump. Consists of an outdoor unit and a coil in the forced air distribution system, usually in a fossil fuel furnace. These systems are electrically powered and provide cooling. *Single packaged central air conditioner* - similar to single packaged air source heat pumps, providing cooling only. *Through-the-wall ductless air source heat pump* - a single packaged air source heat pump designed to be installed without a distribution system. Provides both heating and cooling and is usually installed through an exterior wall. *Window/through-the-wall air conditioner* - a single packaged ductless air conditioner designed to be installed without a distribution system. *Direct evaporative cooler* - is used primarily in very dry climates. Evaporative coolers work by blowing air over a damp pad or by spraying a fine mist of water into the air. Direct evaporative coolers add moisture to the home. *Indirect evaporative cooler* - evaporation takes place on only one side of a heat

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type (continued)	Identify type(s) of equipment for heating and/or cooling (continued)	*Absorption cooler* - this is a gas air conditioner. Look for a cooling tower, an exhaust pipe, a gas burner to evaporate refrigerant and a heat exchanger similar to an electric air conditioner. *Unitary space heater* - these are fossil fuel burning heaters which have individual controls and no distribution system. They may be equipped with a fan for forcing air circulation over a heat

		exchanger, or they may use simple convective forces. These heaters are typically mounted on outside walls in order to facilitate venting and can use natural gas, kerosene, propane, or other types of fossil fuel.
Location	Determine the location of heating and cooling equipment	Note whether systems are located in conditioned or unconditioned space.

Building Element: Domestic Hot Water System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Efficiency	Determine the Energy Factor or Seasonal Efficiency of the water heater	<u>Storage Water Heater</u> Look for the water heater's rating plate and product literature. Some water heaters will list their EF right on the rating plate. If the water heater is wrapped and there is no accessible information, approximate the age of the unit and use a default efficiency. If accessible, record the Make and Model #. Look up the EF rating of that model in an appropriate efficiency rating directory. If the EF rating is not listed in the directory use a default based on the estimated age of the water heater. <u>Instantaneous Water Heaters</u> Check the unit's nameplate for the RE (Recovery Efficiency). If a gas model, note whether there is a standing pilot light.
Building Element: Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**

Extra tank insulation value	Determine the insulation value of any exterior wrap	Visually determine if the water heater is wrapped with exterior insulation. If so, measure thickness of the wrap and determine R-value.
Location	Determine location of storage tank	Determine whether water heater is located in conditioned or unconditioned space.
Pipe insulation value	Determine the insulation value of the pipes	Determine whether pipe insulation is installed on all 3/4" or larger, non-recirculating hot water mains. Measure depth of insulation and identify material to determine R-value.
System type	Determine type and heat source of water heater	<u>Storage</u> These water heaters are the most common type. Water is heated in an insulated tank that typically ranges in capacity from 30 to 75 gallons. Storage water heaters may use electric resistance, gas, propane, oil or electric heat pump. *Storage electric* -look for rigid or flexible 240 A/C conduit, UL seal, no vent, no burner or pilot tubing. Thermostats are usually hidden behind metal access doors. Often there is both an upper and a lower thermostat. *Storage gas* -look for a vent connection (top of tank), gas connector and line valve, thermostat, burner and pilot tubing, burner compartment doors, and "AGA" seal rating plate. Most gas water heaters have legs to lift the unit above the floor level to provide combustion air to the burner. *Storage propane* -look for the same features as those listed for gas water heaters. Also, look for a rating plate or tag that states "For Use with LP Gas Only." *Storage oil* -look for features that are similar to a gas water heating storage system. In addition, oil systems are usually furnished with draft regulators which are attached to the vent pipe between the tank and chimney (hinged metal flap with counterweight to allow for variations in flue gas pressure). Vent dampers may also be apparent on the vent pipe. *Storage heat pump* -water heaters remove heat from the air in the room where they are located and then release the heat to the water in the storage tank. Look for the same features as those

		found on electric water heating systems. In addition, there will be a fan, condenser and evaporator. Also, the system may be one single unit, or may be a split system.

Building Element: Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
System type (continued)	Determine type and heat source of water heater (continued)	*Combination DHW/furnace system* - natural gas combo systems use heat drawn from a hot water tank circulating through an air handling module to heat the space. *Geothermal heat pump de-superheaters* - devices which utilize heat pump cycle superheater to heat domestic hot water. Look for insulated lines between air handler unit and storage water heater tank. <u>Instantaneous</u> These water heaters heat water on demand, instead of storing pre-heated water in a large tank. They are usually small units, with storage of no more than 2 gallons, and are often attached to a wall close to the point of use. Instantaneous water heaters may be used in addition to a primary storage water heater to serve fixtures in a distant location of the house, so check for a main storage unit as well. Determine if the instantaneous heater uses gas or electricity. *Instantaneous gas* - look for a connector and line valve, vent connection, thermostat, burner and pilot tubing, and AGA seal. Check whether unit has a pilot light or intermittent ignition device. *Instantaneous electric* - look for the absence of a gas line, vent or pilot light. Look for a UL seal. *Super-heater* - check for this supplementary heat source.

Building element: Solar Domestic Hot Water System

Rated Feature	Task	On-Site Inspection Protocol
Collector	Determine area, orientation, and tilt of collector	Determine the area of the collector. Determine the orientation of the solar collector by taking a compass reading (adjusting for magnetic deviation) in the direction toward which the collector faces. Determine the tilt of the collector. A site selection and angle finder instrument can be used to determine the tilt of the collector. Geometric calculations based on horizontal length and vertical height measurements can also be used.
Efficiency	Determine efficiency of solar system	Look for SRCC label. Check for SRCC system and component name plates. Refer to the Directory of SRCC Certified Solar Collector and Water Heating System Ratings, or other SRCC literature for energy factor (EF) and other performance data.
Extra tank insulation value	Determine the insulation value of any exterior wrap	See Domestic Hot Water, above.
Pipe insulation value	Determine the insulation value of the pipes	Determine the R-value of insulation installed on pipes.
Solar collector type	Identify type of solar collector	Identify the type of solar collector by checking for the SRCC label or manufacturer's information.
Storage tank size and location	Determine the capacity of the storage tank and location	To determine the size of the storage tank refer to documentation or a label indicating the tank capacity. Note if storage is inside or outside of conditioned space.

Building element: Solar Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
System type	Determine type of solar systems	Identify whether a solar domestic hot water system exists. These systems collect and store solar thermal energy for domestic water heating applications. If a solar water heating system

		exists, determine system type. For systems manufactured after Jan. 1, 1995, system type, energy factor (EF), and other performance characteristics shall be determined from the SRCC label (usually affixed to the solar storage tank) and by referring to SRCC literature. For systems lacking an SRCC label, energy factor and other performance characteristics can be determined using a certified HERS modeling tool, or appropriate default values. Identify as passive or active. Base your evaluation on these criteria: *Passive* - No purchased electrical energy is required for recirculating water through a passive solar collector. Three types of passive systems are integrated collector storage (ICS), thermosiphon systems and self-pumped systems. *Integrated Collector Storage (ICS)* - consists of a single unit which incorporates both collector and water storage. An example is the common "bread box" design. Storage is usually outside the conditioned space. *Thermosiphon* - consists of a flat-plate solar collector and hot water storage tank. Instead of using a pump, circulation of the fluid is achieved by natural convection action. The storage tank must be located above the collector, and is usually outside the conditioned space. *Self-pumped* - circulates fluid from storage to collectors without purchased electrical energy. Photovoltaic and percolating systems are examples of self-pumped systems. The storage tank is usually inside the conditioned space. *Active* -Also known as pumped systems. *Pumped* -purchased electrical energy input is required for operation of pumps or other components. The storage tank is usually inside the conditioned space.

Building Element: Passive Solar Heating System

Rated Feature	Task	On-Site Inspection Protocol
Direct gain	Identify system type and determine solar aperture orientation, aperture area	A solar direct gain system can reduce heating, cooling, and lighting energy requirements through proper sizing, placement, orientation, and/or control of windows, skylights, shading devices, and solar storage mass within the building. To determine aperture area, measure width and height of south-facing glazing and indicate tilt angle. Note glass type(s) (e.g., double glazing) and presence of night insulation (if any). Determine orientation with a compass reading (adjusted for magnetic deviation). Determine the type of thermal mass, its thickness and dimensions. Determine if the mass will be lit by direct solar rays between the hours of 9:00 a.m. and 3:00 p.m. during the winter. Note any trees or other obstructions to solar gain.
Greenhouse or solarium	Identify system type and determine solar aperture orientation, aperture area and information about thermal mass	A greenhouse or solarium creates a South-glazed buffer zone between the house and the exterior and can help heat the living area. They may be used in conjunction with thermal mass (such as bricks or drums filled with water) to store heat and reradiate it at night. See Direct gain, above, for specific inspection items.

Building Element: Passive Solar Heating System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Thermal storage mass	Identify system type and determine solar aperture orientation, aperture area and information about thermal mass	Thermal mass systems consist of solar-exposed heavyweight materials with high heat capacitance and relatively high conductance (high thermal diffusivity) such as masonry, brick, concrete, tile, stone, or water placed in the same zones(s) as the solar collection area(s). These elements may be integral with the building or distinct elements within the building. Distinct components: *Trombe wall* -uses a heat storage mass placed between the glass and the space to be heated.

		Measure area of storage mass, determine material, thickness, and capacitance. *Water wall* -replaces the existing wall, or parts of it, with containers that hold water.
Thermosiphon Air Panel (TAP)	Identify system type	*Thermosiphon air panel (TAP)* -has one or more glazing layers of glass or plastic, an air space, an absorber, another air space, and (often) an insulated backing. These are similar in appearance to active flat-plate collectors, often mounted vertically on walls, or ground-mounted, so that the living space is higher than the collector to facilitate convection from the TAP to the house. See Greenhouse, above, for specific inspection items.