

Alternative Quality Insulation Installation Procedures for Spray Polyurethane Foam (SPF) Insulation: Medium-Density Closed Cell and Low-Density Open Cell SPF

a. Purpose

These procedures detail the installation and inspection protocols necessary to qualify for the allowed energy credit for High Quality Insulation Installation (QII) for spray polyurethane foam (SPF) insulation. These procedures must be field verified before the building construction permit is finalized in order to claim the QII energy compliance credit for SPF insulation.

The energy credit is available for low rise-residential buildings after verification is made by a certified Home Energy Rating System (HERS) rater. These procedures and energy credit apply to a wood or metal framed wall, floor, ceiling, and/or roof assemblies insulated with SPF insulation.

b. Scope

These procedures apply to two types of SPF used as building insulation: medium-density closed cell SPF (ccSPF) and low-density open cell SPF (ocSPF). Most often, the same procedures will apply to both ccSPF and ocSPF. However, in some construction situations the procedures will be different.

NOTE 1: High-rise residential, hotel/motel, and nonresidential buildings are required to follow these procedures when ccSPF insulation is installed, and a certified HERS rater is required to verify compliance with these procedures.

NOTE 2: For ccSPF, these procedures or the procedures in JA7 of the Reference Appendices shall be used.

c. Thermal Specification

ccSPF

A spray applied polyurethane foam insulation having a closed cellular structure resulting in an installed nominal density of 1.5 to less than 2.5 pounds per cubic foot (pcf).

R-value: The total R-value shall be calculated based on the nominal required thickness of the insulation multiplied by a thermal resistivity of 5.8 per inch. Based on this calculation, the overall assembly U-factor shall be determined by selecting the assembly that matches the assembly type, framing configuration, and cavity insulation from the appropriate Reference Joint Appendix JA4 table. The R-value of ccSPF insulation shall meet or exceed the installed thickness specified in Table 1 below.

Alternatively, the R-value of the installed insulation shall be based on the verified thickness at an R-value of 5.8 per inch. Approved compliance software shall make appropriate adjustments to account for the R-value and U-factor effects of the ccSPF assembly.

Nominal Thickness: ccSPF sprayed into framed cavities or on flat surfaces will expand with variable thicknesses, visibly appearing as undulations on the surface of the insulation. The average thickness of the foam insulation must meet or exceed the required R-value. Depressions in the foam insulation's surface shall not be greater than 1/2-inch of the required thickness at any given point of the surface area being insulated.

See the Certificate of Compliance for the minimum R-values required for compliance with the Standards.

Filling of Framed Assemblies:

ccSPF insulation is not required to fill the cavities of framed assemblies provided the installed thickness of insulation conforms to compliance documentation and that the bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 2.0 inches away from the framing for ocSPF insulation, or filled to the thickness meeting ASTM testing as an air barrier.

Air Barrier: ccSPF installed as an air barrier shall be a minimum of 2.0 inches in thickness; alternatively, ccSPF insulation shall be installed at a thickness that meets an air permeance no greater than 0.02 L/s-m² at 75 Pa pressure differential when tested in accordance to ASTM E2178 or ASTM E283.

ocSPF

A spray applied polyurethane foam insulation having an open cellular structure resulting in an installed nominal density of 0.4 to less than 1.5 pounds per cubic foot.

R-value: The total R-value shall be calculated based on the nominal required thickness of the insulation multiplied by a thermal resistivity of 3.6 per inch. Based on this calculation, the overall assembly U-factor shall be determined by selecting the assembly that matches the assembly type, framing configuration, and cavity insulation from the appropriate Reference Joint Appendix JA4 table. The R-value of ocSPF insulation shall meet or exceed the installed thickness specified in Table 1 below.

Alternatively, the R-value of the installed insulation shall be based on the verified thickness at an R-value of 3.6 per inch. Approved compliance software shall make appropriate adjustments to account for the R-value and U-factor effects of the ocSPF assembly.

Nominal Thickness: ocSPF sprayed into framed cavities or on flat surfaces will expand with variable thicknesses, visibly appearing as undulations on the surface of the insulation. The average thickness of the foam insulation must meet or exceed the required R-value. Depressions in the foam insulation surface shall not be greater than 1 inch of the required thickness provided these depressions do not exceed 10% of the surface area being insulated.

See the Certificate of Compliance for the minimum R-values required for compliance with the Standards.

Filling of Framed Assemblies:

ocSPF insulation shall completely fill cavities of 2x4 inch framing or less. Cavities greater than 2x4 inch framing dimensions may be filled to the thickness that meets the required R-value used for compliance provided that the bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 5.5 inches away from the framing for ocSPF insulation, or filled to the thickness meeting ASTM testing as an air barrier.

Air Barrier: ocSPF installed as an air barrier shall be a minimum of 5.5 inches in thickness; alternatively, ocSPF insulation shall be installed at a thickness that meets an air permeance no greater than 0.02 L/s-m² at 75 Pa pressure differential when tested in accordance to ASTM E2178 or ASTM E283.

Table 1: Required Thickness of SPF Insulation to Achieve Specified R-values

Thickness of SPF Insulation	R11	R13	R15	R19	R21	R22	R25	R30	R38
Required thickness of ccSPF Insulation (inches)	2.00	2.25	2.75	3.50	3.75	4.00	4.50	5.25	6.75
Required thickness of ocSPF Insulation (inches)	3.0	3.5	4.2	5.3	5.8	6.1	6.9	8.3	10.6

d. Terminology

Continuous Air Barrier	<p>A combination of interconnected materials and assemblies joined and sealed together to provide a continuous air-tight boundary of the building envelope separating conditioned from unconditioned space, or adjoining conditioned spaces of different occupancies or uses. Insulation must be in substantial contact with the assembly air barrier for the insulation to perform at its rated R-value.</p> <p>Note: SPF insulation used as the air barrier shall be a minimum of 5.5 inches in thickness for ocSPF or 2.0 inches in thickness for ccSPF; alternatively, SPF insulation shall be installed at a thickness that meets an air permeance no greater than 0.02 L/s-m² at 75 Pa pressure</p>
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	differential when tested in accordance to ASTM E2178 or ASTM E283. The bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, shall be sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 5.5 inches away from the framing for ocSPF or 2.0 inches away from the framing for ccSPF insulation respectively, or filled to the thickness meeting ASTM testing as an air barrier.
Air-tight	Not permitting the passage of air either in to or out of the building envelope. <u>Note:</u> Thermal envelope assemblies (such as wall assemblies) shall be built to minimize air movement. Air movement brings unconditioned air and moisture through or into the assembly. For these procedures, air-tight shall be defined as an assembly or air barrier with all openings greater than 1/8 inch caulked, or sealed with minimally expansive foam.
Compression	Compacting of insulation in an assembly that results in elimination of the air pockets trapped in the material that gives the insulation its R-value per inch. Insulation should be "lofted" or properly field applied to a manufacturer specified density to achieve its full R-value. Limited compression is allowed at plumbing, vents, and other obstructions and in cavities of non-standard framing. Compression of insulation in these situations by more than 50% is excessive and shall not be allowed.
Draft Stops	A material, device or construction installed to prevent the movement of air through open spaces or concealed areas within building components, such as crawl spaces, floor/ceiling assemblies, wall assemblies, roof/ceiling assemblies and attics. <u>Note:</u> Draft stops are important components of the air barrier and shall be air-tight. Fire blocks constructed of porous insulation materials cannot serve as draft stops since they are not air tight.
Gaps	Uninsulated areas at the edge of insulation where insulation is not in contact with framing members or other materials at the edge of the insulation. Gaps occur when insulation length and width is too short for the cavity. Gaps in insulation are avoidable and are not permitted.
Hard Covers	Building materials, such as plywood, hardboard, or gypboard, which become part of the ceiling air barrier. <u>Note:</u> Hard covers shall be installed above areas where there is a drop ceiling. For example, a home with 10ft ceilings may have an entry closet with a ceiling lowered to 8ft. In this case, a hard cover is installed at the 10ft level above the entry closet. Hard covers become part of the ceiling air barrier and shall be air-tight.
Minimally Expansive Foam Sealing Material	A single-component polyurethane foam system typically formulated in a handheld can or portable container to seal and fill construction gaps and crevasses, holes, and cracks without distorting adjacent framing. These materials are not used for insulation purposes, only as agents for air sealing of gaps and crevasses that are too small to be insulated.
Net Free-Area	The net free-area of a vent cover is equal to the total vent opening less the interference to air flow caused by a screen or louver used for ventilation. Screened or louvered vent opening covers are typically marked by the manufacturer with the "net free-area." For example a 22.5 in. by 3.5 in. eave vent screen with a total area of 78.75 square inches may have a net free-area of only 45 square inches.
Spray Polyurethane Foam (SPF)	A foamed plastic insulation material formed by the reaction of an isocyanurate and a polyol that uses a blowing agent to develop a cellular structure when spray applied onto a substrate. SPF insulation is a two-component reactive system mixed at a spray gun. SPF insulation can be formulated to have specific physical properties (i.e., density, compressive strength, fire resistance and R-value) appropriate for the application requirements.
Voids & Air Spaces	An uninsulated space within an enclosed building assembly created where the assembly has been insulated by partial filling of the framed cavity. The partial fill results in an air space (void) between the insulation surface and the assembly's exterior or interior layers which form the assembly's air barrier. Voids occur when insulation depth is too shallow to provide the expected R-value and for the insulation to maintain contact with the assembly's air barrier.

e. Requirements for Walls, Roof/Ceilings, and Floors

- The installer shall determine and the HERS rater shall verify that the manufacturer's nominal insulation thickness has been installed and certified and that all requirements of the Certificate of Field Verification and Diagnostic Testing (CF-4R) have been met.
- The installer shall determine and the HERS rater shall verify that insulation is in substantial contact with the assembly air barrier. When SPF insulation is being used to provide air barrier control, the SPF insulation must cover and be in contact with the entire surface of the framing, filling the cavity to a distance away from the framing specified in "Filling of Framed Assemblies" above.
- SPF insulation shall be applied by SPF applicators trained and experienced in the use and maintenance of high-pressure, plural-component equipment. SPF applicators shall be certified by the SPF insulation manufacturer for the application of SPF insulation systems.
- SPF insulation shall be spray-applied to fully adhere to assembly framing, floor and ceiling joists, and other framing surfaces within the construction cavity. When multiple layers of SPF material are applied, each foam lift (i.e., spray application) shall have adhesion at substrate and foam interfaces. SPF insulation shall not exhibit areas that:
 - Have voids or gaps in the uniformity of the insulation
 - Are extremely soft or spongy
 - Show the presence of liquid
 - Have blistering between lifts
 - Show differences in coloration of adjacent foam layers
 - Indicate the presence of other materials between lifts
- SPF insulation shall be installed in conformance with the manufacturer's specifications, recommendations and temperature/humidity limitations.
- Substrates to which SPF insulation is applied shall be secure and free of surface moisture, frost, grease, oils, dirt, dust or other contaminants that would adversely affect SPF adhesion.
- SPF insulation shall meet all provisions of the California Building Code (CBC), Title 24, Parts 2 and 2.5, SPF shall be separated from occupied spaces by an approved thermal barrier, such as 0.5 inch gypsum wallboard or other approved material, or show equivalence through testing in accordance with CBC, Title 24, Part 2, Section 2603, and Part 2.5, Section R316.
- In unvented attics where SPF insulation is used to insulate roof and attic surfaces, and fuel burning appliances are present (i.e., gas furnace, water heater), the HERS rater shall verify the appliance manufacturer's allowance for the equipment's use in unvented applications.
- Materials shall comply with flame spread index and smoke developed index requirements of the CBC, Title 24, Part 2, Section, 2603.5.4.
- Materials shall meet California Quality Standards for Insulating Material, Title 24, Part 12, Chapter 4, Article 3, and be listed in the California Department of Consumer Affairs Consumer Guide and Directory of Certified Insulating Materials.

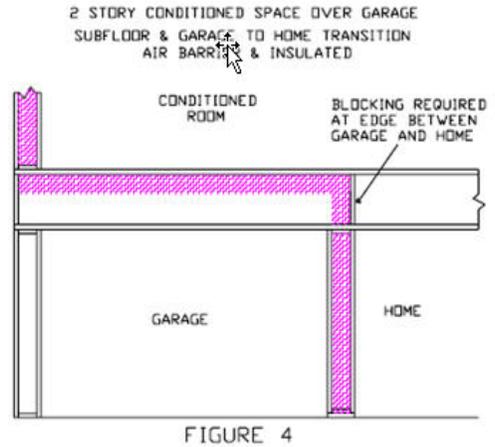
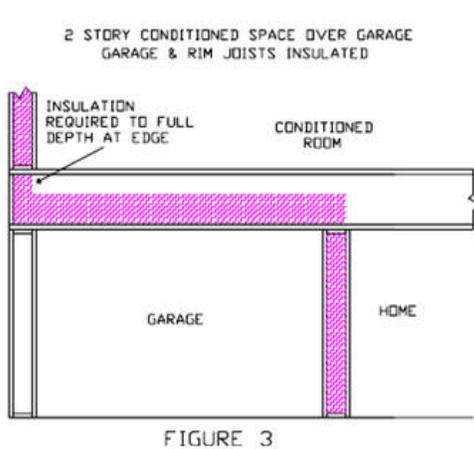
f. Raised Floors and Floors Over Garages

- a. Raised Floors
 - SPF insulation shall be spray-applied to fully adhere to the bottom side of the floor sheathing
 - SPF insulation shall uniformly cover the cavity side-to-side and end-to-end

b. Floors Over Garages

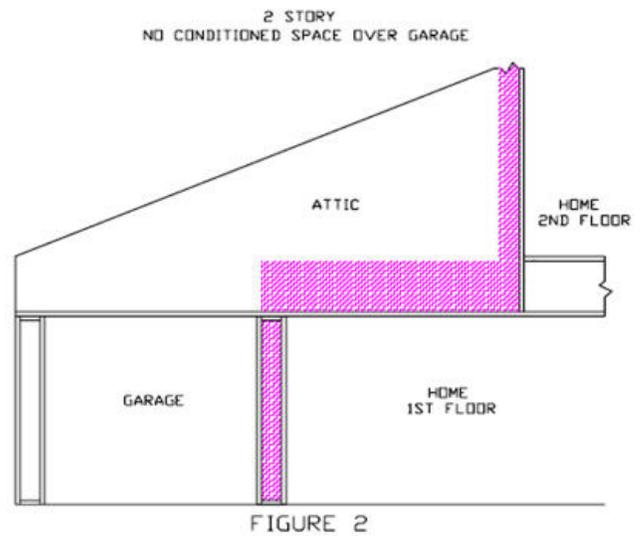
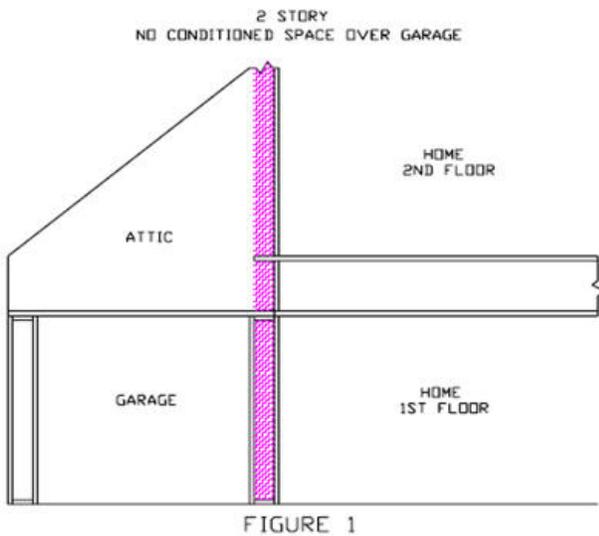
Homes with Conditioned Space over the Garage

The floor over the garage shall be insulated by spraying SPF insulation to fully adhere to the subfloor of the conditioned space. The garage and the adjacent conditioned space (house) shall be insulated up to the subfloor. SPF insulation shall cover any gaps between the header and the floor joist.



Homes with No Conditioned Space over the Garage

The band joist where the garage transitions to an attic above conditioned space shall have an air barrier installed in contact with the edge of the attic insulation.



g. Wall Insulation

a. SPF Application

- In wall cavities, SPF insulation shall be applied to provide an air-tight envelope to the outdoors and between adjoining cavity surfaces of conditioned and unconditioned space, such as the: attic, garage, and crawl space. Special attention shall be paid to plumbing and wiring penetrations

through the top and bottom plate framing, and electrical boxes that penetrate the sheathing and the sheathing seal to the top and bottom plate framing.

- SPF insulation installation shall uniformly cover the cavity side-to-side and end-to-end and shall be installed to cover and form an air barrier on the framing at the top, bottom and sides of each cavity.

Filling of Framed Assemblies:

ocSPF insulation shall completely fill cavities of 2x4 inch framing or less. Cavities greater than 2x4 inch framing dimensions may be filled to the thickness necessary to meet the required R-value used for compliance provided that the bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 5.5 inches away from the framing for ocSPF insulation, or filled to the thickness meeting ASTM testing as an air barrier.

ccSPF insulation is not required to fill the cavities of framed assemblies provided the installed thickness of insulation conforms to compliance documentation and the bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 2.0 inches away from the framing for ccSPF insulation, or filled to the thickness meeting ASTM testing as an air barrier.

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b. Narrow-Framed Cavities

- Non-standard width cavities shall be filled with SPF insulation at a depth consistent with the SPF thickness required to achieve the specified R-value.
- Narrow spaces less than 1 inch in width at windows and door jambs shall be filled with minimally expansive foam sealing material or batt insulation snugly fitted into the space (without excessive compression) or loose fill insulation.
- Narrow spaces less than 2 inches in width, such as between studs at the building corners and at the intersections of partition walls, shall be filled with batt insulation snugly fitted into the space (without excessive compression), loose fill insulation, or minimally expansive foam.

h. Special Situations

a. Installations Prior to Exterior Sheathing or Lath

- Hard to access wall stud cavities such as corner channels, wall intersections, and behind tub/shower enclosures shall be insulated to the required R-value. In most cases this can only be done prior to the installation of the tub/shower or the exterior sheathing or stucco lath.
- An air barrier shall be installed on the inside of exterior walls directly adjacent to tub/shower enclosures.

b. Obstructions and Wall Penetrations

- SPF insulation shall be applied to fully seal around wiring and plumbing.
- SPF insulation shall be applied to fully seal between the sheathing and the rear of electrical boxes and phone boxes.
- In cold climates, where water pipes may freeze (Climate Zones 14 and 16), pipes shall have at least two-thirds of the insulation between the water pipe and the outside surface of the exterior

wall. If the pipe is near the exterior finish assembly layers, as much insulation as possible shall be placed between the pipe and the exterior assembly material.

c. Rim Joists

- All rim-joists shall be insulated to the same R-value as the adjacent walls.
- The insulation shall be installed without gaps or voids.

d. Kneewalls, Skylight Shafts and Gable Ends

- Framing for kneewalls and skylight shafts that separate conditioned from unconditioned space shall be insulated to a minimum of R-19 or greater as specified in the compliance documentation.
- Insulation for all kneewall and skylight shafts shall be completely enclosed by vertical and horizontal framing, including horizontal plates at top and bottom of the insulation.
- In unvented attics, where SPF is applied directly to the underside of the roof deck, skylight shafts shall be insulated to a minimum of R-19, and all gable ends between conditioned and unconditioned space shall be insulated to the same R-value as the exterior walls as specified in the compliance documentation.
- SPF insulation shall be installed without gaps.
- SPF insulation shall be fully adhered and self-supporting so that it will remain in place.

Filling of Framed Assemblies:

ocSPF insulation shall completely fill cavities of 2x4 inch framing or less. Cavities greater than 2x4 inch framing dimensions may be filled to the thickness necessary to meet the required R-value used for compliance provided that the bottom and top plates of vertical framing and both ends of horizontal framing, including band and rim joists, are sprayed to completely fill the cavity adjacent to and in contact with the framing to a distance of 5.5 inches away from the framing for ocSPF insulation, or filled to the thickness meeting ASTM testing as an air barrier.

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Air Barrier: ocSPF installed as an air barrier shall be a minimum of 5.5 inches in thickness; alternatively, ocSPF insulation shall be installed at a thickness that meets an air permeance no greater than 0.02 L/s-m² at 75 Pa pressure differential when tested in accordance to ASTM E2178 or ASTM E283.

e. HVAC/Plumbing Closet

- Walls of interior closets for HVAC and/or water heating equipment that require combustion air venting, shall be insulated to the same R-value as the exterior walls as specified in the compliance documentation.

f. Double Walls and Framed Bump-Outs

- Insulation shall fill the entire cavity; or, an additional air barrier shall be installed inside the double wall or bump-out and in contact with the insulation so that the insulation fills the cavity formed with the additional air barrier.
- Entire double walls and framed bump-outs shall be air tight.
- SPF insulation shall be applied to fully adhere to all sides and ends of assembly framing and to form a complete air seal within the construction cavity.

g. Structural Bracing, Tie-downs, Steel Structural Framing

- Framing and bracing used for structural purposes shall be identified on plan documents with diagrams and/or design drawings.
- Insulation shall be installed in a manner that restricts thermal bridging through the structural framing assembly.
- SPF insulation shall be applied to fully adhere to all sides and ends of assembly framing and to form a complete air seal within the construction cavity.

i. Ceiling and Roof Insulation

a. General Requirements

- SPF insulation shall be applied to fully adhere to the substrate of the ceiling or roof deck.
- SPF insulation shall be applied to fully adhere to all sides and ends of assembly framing and to form a complete air seal within the construction cavity.
- SPF insulation shall be applied to fully adhere to and seal around wiring and plumbing.
- Hard covers shall be placed over all drop ceiling areas and interior wall cavities to keep insulation in place and stop air movement. Hard covers shall be in place before insulation is installed.
- In vented attics, required eave ventilation shall not be obstructed; the net free-ventilation area of the eave vent shall be maintained.
- In unvented attics where SPF is applied directly to the underside of the roof deck, all gable end areas shall be insulated to the same R-value as the walls and as specified on compliance documentation. It is not necessary to place hard covers over drop ceilings and interior wall cavities in this situation.
- All recessed light fixtures that penetrate the ceiling shall be IC rated and air tight rated and shall be sealed with a gasket or caulk between the housing and the ceiling.
- SPF insulation shall not be applied directly to recessed lighting fixtures. Recessed light fixtures must be either insulated with CBC approved materials (i.e., mineral fiber) or enclosed in a box fabricated from ½-inch plywood, 18 gauge sheet metal, 1/4-inch hard board, drywall or other approved materials. The exterior of the box may then be insulated with SPF. Fixtures that are not air tight and rated for insulation contact (IC) shall be removed and/or replaced.

b. Enclosed Rafter Ceilings

- SPF insulation shall be kept away from combustion appliance flues in accordance with the flue manufacturers' installation instructions or labels on the flue for clearance.
- Prior to installation, verify that the building official permits SPF insulation directly applied to the underside of the roof deck and/or allows unvented rafter spaces.

c. HVAC Platform

- A minimum of 3 inches of ccSPF insulation or 5.3 inches of ocSPF shall be placed below any platform or cat-walk access ways installed in vented attics for HVAC equipment or other needs. The overall assembly R-value shall meet the R-values specified in the compliance documentation.

d. Attic Access

- A minimum of 3 inches of ccSPF or 5.3 inches of ocSPF insulation shall be placed to the access door assuring good adhesion to the door surface. Alternatively, permanently attach rigid foam or batt insulation with adhesive or mechanical fastener. The overall assembly R-value shall meet the R-value specified in the compliance documentation.

e. Attics and Cathedral Ceilings

- Prior to installation verify that the building official permits SPF insulation to be directly applied to the underside of the roof.
- In vented and unvented attics where entry is made for the service of utilities, SPF applied in direct contact with the underside of the roof deck shall be protected from ignition in accordance with CBC, Part 2, Section 2603, and Part 2.5, Section R316.
- In unvented attics, where SPF is applied directly to the underside of the roof deck, all gable ends shall be insulated to the same R-value as the exterior walls as specified in the compliance documentation.
- In unvented attics where SPF insulation is used to insulate roof and attic surfaces, and fuel burning appliances are present (i.e., gas furnace, water heater), the HERS rater shall verify the appliance manufacturer's allowance for the equipment's use in unvented applications.

j. R-value Measurement Equipment

- HERS Raters shall measure the installed thickness of insulation in at least 6 random locations on walls, roof/ceilings and floors (i.e., 6 measurements per opaque surface type: wall, roof/ceiling or floor) to ensure minimum thickness levels necessary to meet the R-value specified on the Certificate of Compliance, CF-1R and CR-6R. Measurement areas shall include low and high areas of the SPF insulated surface.
- Probes for inspection of installed thickness of SPF insulation: The insulation thickness shall be verified by using a probe, gauge or device capable of measuring the installed thickness of insulation. A pointed measurement probe or other gauge or device, capable of penetrating the full thickness of the insulation, shall be used having measurements marked by at least one-eighth inch increments. Insulation thickness measurement probes and gauges or devices shall be accurate to within $\pm 1/8$ inch and shall be designed and used in a manner to cause minimal damage to the insulation.

k. Certificates

- All provisions of Residential Appendix RA2 shall be met. An Insulation Certificate (CF-6R) signed by the SPF applicator that states that the installation is consistent with the plans and specifications for which the building permit was issued shall be provided. The certificate shall also state the installing company name, insulation manufacturer's name and material identification, and that the labeled installed nominal thickness and installed R-value for SPF insulation meets those specified in Section 3, Thermal Specification. The SPF applicator shall also attach a manufacturer's R-value chart or Specification Sheet with insulation coverage information for every insulation material used.

l. Certificates and Measuring Probe Availability

- All provisions of Residential Appendix RA2 shall be met. The CF-6R with complete information, signed by the SPF applicator, and a measuring probe or similar device shall be available at the building site for the HERS rater's verification inspection. Note: The HERS rater shall not verify compliance credit without these completed forms.