Residential Appendix RA4

Appendix RA4 Appendix RA4 – Eligibility Criteria for Energy Efficiency Measures

RA4.1 Purpose and Scope

This appendix contains the eligibility requirements which must be met when any of the following features are installed to achieve compliance with the residential building energy efficiency standards.

RA4.2 Building Envelope Measures

RA4.2.1 Roofing Products (Cool Roofs)

Roofing products shall meet specific eligibility and installation criteria to receive credit for compliance. All products qualifying for compliance with §110.8, §140.1, §140.2, §140.3(a)1, §141.09(b)1B, §150.1(cf)12, and §152(b)1H shall be rated and labeled by the Cool Roof Rating Council in accordance with §10-113. The use of a roofing product shall be listed on the Certificate of Compliance.

RA4.2.2 Radiant Barriers

Radiant barriers shall meet specific eligibility and installation criteria to be modeled by any compliance software and receive energy credit for compliance with the Building Energy Efficiency Standards for low-rise residential buildings.

The emittance of the radiant barrier shall be less than or equal to 0.05 as tested in accordance with ASTM C1371 or ASTM E408.

Installation shall conform to ASTM C1158 (Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Building Construction), ASTM C727 (Standard Practice for Installation and Use of Reflective Insulation in Building Constructions), ASTM C1313 (Standard Specification for *Sheet Radiant Barriers for Building Construction Applications*), and ASTM C1224 (*Standard Specification for Reflective Insulation for Building Applications*), and the radiant barrier shall be securely installed in a permanent manner with the shiny side facing down toward the interior of the building (ceiling or attic floor). Moreover, radiant barriers shall be installed at the top chords of the roof truss/rafters in any of the following methods:

i. Draped over the truss/rafter (the top chords) before the upper roof decking is installed.

ii. Spanning between the truss/rafters (top chords) and secured (stapled) to each side.

iii. Secured (stapled) to the bottom surface of the truss/rafter (top chord). A minimum air space shall be maintained between the top surface of the radiant barrier and roof decking of not less than 1.5 inches at the center of the truss/rafter span.

iv. Attached [laminated] directly to the underside of the roof decking. The radiant barrier shall be laminated and perforated by the manufacturer to allow moisture/vapor transfer through the roof deck.

In addition, the radiant barrier shall be installed to cover all gable end walls and other vertical surfaces in the attic.

For Prescriptive Compliance tt~~T~~he attic shall be ventilated to:

i. Conform to the radiant barrier manufacturer's instructions.

ii. Provide a minimum free ventilation area of not less than one square foot of vent area for each 150 ft^2 of attic floor area.

iii. Provide no less than 30 percent upper vents.

Ridge vents or gable end vents are recommended to achieve the best performance. The material should be cut to allow for full airflow to the venting.

The product shall meet all requirements for California certified insulation materials [radiant barriers] of the Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, as specified by CCR, Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.

The use of a radiant barrier shall be listed in the Special Features and Modeling Assumptions listings of the Certificate of Compliance and described in detail in the Residential ACM Manual.

RA4.3 HVAC Measures

RA4.3.1 Ice Storage Air Conditioner (ISAC) Systems

To ensure reliable energy savings and proper operation and control, the applicant worked with the staff to develop eligibility criteria and acceptance testing requirements. The low rise residential building eligibility criteria include third-party field verification of the ISAC's model number by a certified HERS rater and the requirement that duct sealing be completed for all low-rise residential building installations. The Acceptance Requirements call for installer verification of the presence and proper operation of required controls.

The builder or installer provides a Certificate of Compliance form showing the system that was used for determining performance standards compliance, and that duct sealing was specified for compliance.

The following eligibility criteria must be certified on the Installation Certificate and verified by a HERS rater on the Certificate of Field Verification and Diagnostic Testing form for residential buildings (See Reference Appendix RA2).

1. The model number of the installed unit is for a unit that the Energy Commission has approved for compliance credit and matches the model number used for compliance credit.
2. The duct system has been sealed and tested as required by the Reference Appendix RA3.
3. For systems that require charging of the refrigerant lines either a~~No Thermostatic Expansion Valve (TXV)~~Charge Indicatory Light (CID) or refrigerant change test shall be provided. The CID or refrigerant charge credit shall not be taken.~~ credit is taken if applicable~~.

The installing contractor shall complete the following acceptance testing and document the results to the Enforcement Agency using the Installation Certificate (See Reference Appendix RA2).

1. Verify that building cooling is controlled by a standard indoor HVAC thermostat and not by factory-installed controls.
2. Verify that ice making is not controlled by the thermostat.
3. Verify that the water tank is filled to the proper level as specified by the manufacturer.
4. Verify that the correct model number is installed as indicated in compliance documents (including ice melt start time). Certify the installed model number on the CF-1R form.
5. Force the controls to indicate no demand for cooling, set the time to be within the nighttime period, and simulate that the tank is not full with ice. Verify that the system operates properly in the ice-making mode (i.e., it starts charging the tank and does not provide cooling to the building).
6. Force the controls to indicate no demand for cooling, set the time to be within the nighttime period, and simulate the tank being full of ice. Verify that the system operates properly in the idle mode (i.e., the compressor is off, and no cooling is provided by the system).
7. Force the controls to indicate a demand for cooling and set the time to be within the daytime period. Verify that the system operates properly in the ice melt mode (i.e., it starts discharging and that the compressor is off).

8. Force the controls to indicate a demand for cooling and set the time to be within the morning shoulder time period. Verify that the system operates properly in the direct cooling mode (i.e., the system is providing cooling with the compressor).
9. Force the controls to indicate no cooling load, and set the time to be within the daytime period. Verify that the system operates properly in the idle mode (i.e., it does not provide cooling to the building and the compressor is off).
10. Force the controls to indicate a demand for cooling and set the time to be within the nighttime period. Verify that the cooling is provided by the compressor.

RA4.3.2 Evaporatively-Cooled Condensing Units

The eligibility criteria require the measures listed below. These measures must be certified by the installer on the Acceptance Certificate and verified by a HERS rater and certified on the Certificate of Verification.

- EER at 95°F dry bulb and 75°F wet bulb temperature is listed with ARI (generally called EERa).
- EER at 82°F dry bulb and 65°F wet bulb temperature is submitted to ARI and published by the manufacturer in accordance with ARI guidelines (generally called EERb).
- ~~Presence of TXV is verified, if the ARI certified EERs are based on equipment with TXVs~~.
- Ducts are tested and sealed in all installations of this equipment.
- Either a Charge Indicatory Light (CID) or refrigerant change test shall be provided. The CID or refrigerant charge credit shall not be taken.~~Proper refrigerant charge is verified if compliance credit is taken for this measure when TXVs are not installed~~.

RA4.4 Water Heating Measures

RA4.4.1 Proper Installation of Pipe Insulation

Unless otherwise stated, insulation must meet the requirements specified in §150.0(j). Pipe insulation may be omitted where hot water distribution piping is buried within attic, crawlspace or wall insulation, as described below:~~.~~ With batt insulation, ~~In attics and crawlspaces~~ the insulation shall completely surround the pipe with at least 1 inch of insulation and the pipe shall be completely covered with at least ~~4~~2 inches of insulation further away from ~~the~~ unconditioned space. ~~In walls, the~~With blown attic insulation, ~~must completely surround the~~ the pipe must be surrounded with at least ~~1~~4 inches of insulation. If burial within the insulation will not completely or continuously surround the pipe to these specifications, then this exception does not apply, and the pipe must be insulated as specified in §150.0(j). All hot water distribution system piping that is installed below grade must meet the requirements of Insulated Pipes Below Grade. Optional HERS credits are available for HERS inspected installations, as specified in RA4.4.9.1 and RA4.4.9.5-RA4.4.9.7

RA4.4.2 Mandatory Pipe Insulation

Pipe insulation on the first five feet of hot and cold water piping from storage gas water heaters, all underground hot water piping, and all non-recirculating hot water piping of 3/4" diameter or greater are ~~is a~~ mandatory measure as specified in §150.0(j). In addition, all piping installed below grade must be installed in a waterproof and non-crushable casing or sleeve that allows for installation, removal and replacement of the enclosed pipe and insulation. The internal cross-section or diameter of the casing or sleeve shall be large enough to allow for insulation of the hot water piping. Piping below grade that serves any island sinks or other island fixtures or appliances may be insulated with 1/2 inch wall thickness insulation.

Note that **Exceptions** 3, 4 and 5 to §150.0(j) apply to all pipe insulation that is required to meet the mandatory measure requirement or that is eligible for compliance credit.

RA4.4.3 Standard Kitchen (STD)

The standard distribution system design is defined such that all~~All~~ hot water distribution piping from the water heater(s) to the kitchen fixtures (dishwasher(s) and sink(s)) must be insulated to comply with §150.0(j) and be installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable.

RA4.4.4 Pipe Insulation Credit (PIC)

All piping in the hot water distribution system must be insulated from the water heater to the wall behind each fixture or appliance and be installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable~~.~~

RA4.4.5 Insulated Pipes Below Grade (IPBG)

To meet this requirement, all piping installed below grade must be insulated to the levels mandated in §150.0(j). All below grade piping must be installed in a waterproof and non-crushable casing or sleeve that allows for installation, removal and replacement of the enclosed pipe and insulation. The internal cross-section or diameter of the casing or sleeve shall be large enough to allow for insulation of the hot water piping. ~~The last 15 ft of pipe~~Piping ~~-~~below grade ~~hot water distribution piping~~ that serves any island sinks or other island fixtures or appliances may be insulated with 1/2 inch wall thickness insulation.

~~RA4.4.6Uninsulated Pipes Below Grade (UPBG)~~

~~Any below grade hot water distribution system piping which does not meet the requirements for Insulated Pipes Below Grade must use the distribution multiplier for Uninsulated Pipes Below Grade. This applies to all hot water distribution systems.~~

~~RA4.4.7~~RA4.4.6 Parallel Piping (PP)

The length of pipe from the water heater to a single central ~~the~~ manifold shall not exceed 15 ft. The entire length of this pipe shall be insulated to meet the requirements of §150.0(j) and the insulation shall be installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable. The hot water distribution piping from the manifold to the fixtures and appliances must be separated by at least six inches from any cold water supply piping or the hot water piping must be insulated to meet the requirements of §150.0(j) and be installed in accordance with Proper Installation of Pipe Insulation, or Insulated Pipes Below Grade, as applicable. ~~The hot water distribution system piping from the manifold to the kitchen fixtures (dishwasher(s) and sink(s)) must be insulated to meet the requirements of §150(j) and be installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable.~~ In addition, the hot water distribution system piping from the manifold to the fixtures and appliances must take the most direct path.

RA4.4.7 Plan View Compact Distribution System (PVSDS)

To meet this requirement, plan review must verify that the direct distance between the furthest hot water use point and the water heater serving that use point be no more than the distance specified below. Floor Area Served equals the conditioned floor area divided by the number of installed water heaters. For multi-story residences, calculations would be completed by vertically projecting the water heater location to other floors.

Floor Area Served (ft2)	Max Water Heater To Use Point Distance (ft)
< 1000	14’
1001 – 1600	21’
1601 – 2200	26’

2201 – 2800	31’
>2800	34’

~~RA4.4.8Point of Use (POU)~~

~~All hot water fixtures in the dwelling unit, with the exception of the clothes washer, must be located within 8 ft (plan view) of a water heater. To meet this requirement, some houses will require multiple water heaters. In addition, the hot water distribution system piping from the water heater to the fixtures and appliances must take the most direct path.~~

~~RA4.4.9~~RA4.4.8 Recirculation Systems

~~RA4.4.9.1~~RA4.4.8.1 Installation requirements for all recirculation systems

The entire circulation loop in a recirculation system, including return line, must be insulated to a level that meets the requirements of §150.0(j) and be installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable. With the exception of Demand Recirculation, all recirculation systems must have a dedicated return line. A check valve shall be installed in the recirculation loop to prevent unintentional circulation of the water (thermo-siphoning) and back flow when the system is not operating. This check valve may be included with the pump

The circulation loop should be sized and deployed ~~located~~ to minimize the volume of water in the loop and so that there is no more than 15 ft of pipe from the loop to any fixture or appliance (with the exception of the clothes washer).

~~Recirculation systems may take the Pipe Insulation Credit (PIC) if all piping between the circulation loop and all fixtures and appliances is insulated to a level that meets the requirements of §150(j) and the insulation is installed in accordance with Proper Installation of Pipe Insulation or Insulated Pipes Below Grade, as applicable.~~

~~RA4.4.9.2~~Approved recirculation controls include the following:

~~***Recirculation no controls (RNC)***~~

~~***Recirculation systems with no controls must be installed in accordance with the Installation requirements for all recirculation systems.***~~

RA4.4.8.2 Recirculation with non-demand ~~timer~~ controls (RND)~~(RTm)~~

All recirculation controls with the exception of demand controls systems fall under this category. An active control of some sort (timer, temperature, time/temperature) is required.

~~***Recirculation systems with timer controls must be installed in accordance with the Installation requirements for all recirculation systems. Timer controls must have an operational timer initially set to operate the pump no more than 16 hours per day. The timer controls must include automatic resets or a signal function to prevent operation off schedule in the event of a power failure.***~~

~~***Recirculation with temperature control (RTmp)***~~

~~***Recirculation systems with temperature controls must be installed in accordance with the Installation requirements for all recirculation systems. Temperature controls must have a temperature sensor with a maximum 20°F deadband installed on the return line.***~~

~~***Recirculation with time and temperature controls (RTmTmp)***~~

~~***Recirculation systems with time and temperature controls must be installed in accordance with the Installation requirements for all recirculation systems. These systems must meet the requirements for both individual time and temperature controls systems.***~~

RA4.4.8.3 Demand Recirculation; ~~(~~Mm~~anual c~~Control (RDRmc)~~ or motion sensor control (RDRmsc)~~

Demand recirculation systems must be installed in accordance with the ~~Installation~~ insulation requirements of RA4.4.8.1 ~~for all recirculation systems.~~ Demand controlled recirculation systems shall operate “on-demand”, meaning that ~~the~~ pump operation shall be initiated ~~able to receive a signal to turn on from a user~~ shortly prior to the ~~desired~~ hot water draw. The controls shall be electronic and operate on the principal of shutting off the pump with a sensed rise in pipe temperature (Delta-T). If the thermo-sensor that measures temperature rise fails to operate, the electronic controls must have a lock out to disable pump ~~prevent~~ operation when sensed pipe temperature exceeds ~~above~~ 105°F. The electronic controls shall also have a fail safe timer to prevent disable pump~~extended~~ operation longer than five minutes~~of the pump~~ if the sensor fails or is damaged. Either a dedicated return line shall be installed, or the cold water line may be used as a temporary return. Manually controlled systems may be activated by wired or wireless button mechanisms. The manual controls shall be installed in each hot water use point location where there is a sink, shower or tub/shower combination.

RA4.4.8.4 Demand Recirculation; Sensor Control (RDRsc)

~~Motion s~~Sensor controlled demand recirculation systems shall send a signal to activate the pump either when motion or hot water flow is sensed. Once a signal is sent, the ~~motion~~ sensor’s controls must be designed to have a delay of not less than 5 minutes before the next signal can be sent. Motion sensor controls shall be installed in each hot water location where there is a sink, shower or tub/shower combination. .All motion sensors must operate on 12 volts or less with a standby power of 1 watt or less. Flow switches that send a signal to activate the pump may be used as an alternative to, or in conjunction with motion sensor controls. All flow switches must operate on 12 volts or less with a standby power of 1 watt or less. One flow switch shall be installed on~~for~~ each hot water distribution system.

~~**Temperature buffering tank (TBT)**~~

~~Temperature buffering tanks are small storage tanks (typically under 5 gallons) that are installed down line from the primary water heater. Any temperature buffering tank that has an electric resistance heating element must use the temperature buffering storage tank distribution multiplier.~~

Monitoring Control DHW Systems

Systems that qualify as monitoring control domestic hot water systems must be capable of recording hourly water use patterns and using that data to adjust the central system to match supply with hourly demand levels. Qualifying equipment or services must be listed with the Commission.

RA4.4.9 Optional HERS Verification

HERS verification elements have been added to provide additional credits for measures that require field verification. The HERS verification process can be completed on a sampling basis.

RA4.4.9.1 HERS-Verified Pipe Insulation Credit (PIC-H)

Consistent with the requirement of RA4.4.4, this measure includes a visual HERS inspection to verify that all hot water piping in non-recirculating systems is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids with the exception of the last segment of piping that penetrate walls and delivers hot water to the sink, appliance, etc.

RA4.4.9.2 HERS-Verified Parallel Piping (PP-H)

In addition of the requirements specified in RA4.4.7, this measure requires that the measured length of piping between the water heater and single central manifold does not exceed five feet.

RA4.4.9.3 HERS-Verified Compact Hot Water Distribution System (CHWDS-H)

This measure involves HERS field verification to insure that the longest pipe run from any use point to the water heater serving that use point does not exceed a maximum length. The table below defines the maximum pipe length as a function of Floor Area Served, where Floor Area Served equals the conditioned floor area divided by the number of installed water heaters.

Floor Area Served (ft2)	Max Water Heater To Use Point Distance (ft)
< 1000	28’
1001 – 1600	43’
1601 – 2200	53’
2201 – 2800	62’
>2800	68’

RA4.4.9.4 HERS-Verified Point of Use (POU-H)

All hot water fixtures in the dwelling unit, with the exception of the clothes washer, must be located within 8 feet (total piping length) from a water heater. To meet this requirement, most houses will require multiple water heaters.

RA4.4.9.5 HERS-Verified Recirculation with non-demand controls (RND-H)

This measure includes a visual HERS inspection to verify that all recirculating hot water piping is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids.

RA4.4.9.6 HERS-Verified Demand Recirculation: Manual Control (RDRmc-H)

This measure includes a visual HERS inspection to verify that all recirculating hot water piping is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids.

RA4.4.9.7 HERS-Verified Demand Recirculation: Sensor Control (RDRsc-H)

This measure includes a visual HERS inspection to verify that all recirculating hot water piping is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids.

RA4.4.10 Solar Water Heating Systems

Solar water heating systems ~~for individual dwellings~~ shall be rated based on Solar Rating and Certification Corporation (SRCC) values from the OG 100 or~~with the~~ OG 300 Procedure. To use the OG 100 procedure the system must be installed to include all of the features modeled and generated in the California F-chart report. Other solar thermal modeling tools may be used if recognized by Commission staff.

In order to use the OG-300 method, the system must satisfy the following eligibility criteria:

1. The collectors must face within 35 degrees of south and be tilted at a slope of at least 3:12
2. The system shall be SRCC certified.
3. The system must be installed in the exact configuration for which it was rated, e.g. the system must have the same collectors, pumps, controls, storage tank and backup water heater fuel type as the rated condition.
4. The system must be installed according to manufacturer's instructions.
5. The collectors shall be located in a position that is not shaded by adjacent buildings or trees between 9:00 AM and 3:00 PM (solar time) on December 21.

~~6.~~Building Sites that have solar obstructions, such as trees, adjacent buildings, or any feature that reduces solar gain on the collector surfaces, cannot take credit for the use of the solar system.

RA4.5 Other Measures

RA4.5.1 Controlled Ventilation Crawlspace (CVC)

Drainage. Proper enforcement of site engineering and drainage, and emphasis on the importance of proper landscaping techniques in maintaining adequate site drainage, is critical.

Ground Water And Soils. Local ground water tables at maximum winter recharge elevation should be below the lowest excavated site foundation elevations. Sites that are well drained and that do not have surface water problems are generally good candidates for this stem-wall insulation strategy. However, the eligibility of this alternative insulating technique is entirely at the enforcement agency officials' discretion. Where disagreements exist, it is incumbent upon the applicant to provide sufficient proof that site drainage strategies (e.g., perimeter drainage techniques) will prevent potential problems.

Ventilation. All crawl space vents must have automatic vent dampers to receive this credit. Automatic vent dampers must be shown on the building plans and installed. The dampers should be temperature actuated to be fully closed at approximately 40°F and fully open at approximately 70°F. Cross ventilation consisting of the required vent area reasonably distributed between opposing foundation walls is required.

Foam Plastic Insulating Materials. Foam plastic insulating materials must be shown on the plans and installed when complying with the following requirements:

Fire Safety—CBC Section 719. Products shall be protected as specified. Certain products have been approved for exposed use in under floor areas by testing and/or listing.

Direct Earth Contact—Foam plastic insulation used for crawl-space insulation having direct earth contact shall be a closed cell water resistant material and meet the slab-edge insulation requirements for water absorption and water vapor transmission rate specified in the mandatory measures.

RA4.5.2 Mineral Fiber Insulating Materials

Fire Safety—CBC Section 719. "All insulation including facings, such as ~~vapor barrier~~vapor retarders or breather papers installed within ... crawl spaces ... shall have a flame-spread rating not to exceed 25 and a smoke density not to exceed 450 when tested in accordance with ASTM E 84." In cases where the facing is also a vapor retarder, the facing shall be installed to the side that is warm in winter.

Direct Earth Contact—Mineral fiber batts shall not be installed in direct earth contact unless protected by a vapor retarder/ground cover.

~~Vapor Barrier~~Vapor retarder (Ground Cover). A ground cover of 6 mil (0.006 inch thick) polyethylene, or approved equal, shall be laid entirely over the ground area within crawl spaces.

The ~~vapor barrier~~vapor retarder shall be overlapped 6 inches minimum at joints and shall extend over the top of pier footings.

The ~~vapor barrier~~vapor retarder should be rated as 1.0 perm or less.

The edges of the ~~vapor barrier~~vapor retarder should be turned up a minimum of four inches at the stem wall.

Penetrations in the ~~vapor barrier~~vapor retarder should be no larger than necessary to fit piers, beam supports, plumbing and other penetrations.

The ~~vapor barrier~~vapor retarder must be shown on the plans and installed.

Studies show that moisture conditions found in crawl spaces that have minimal ventilation do not appear to be a significant problem for most building sites provided that the crawl-space floors are covered by an appropriate ~~vapor barrier~~vapor retarder and other precautions are taken. The Energy Commission urges enforcement agency officials to carefully evaluate each application of this insulating technique in conjunction with reduced ventilation because of the potential for adverse effects of surface water on crawl-space insulation that could negate the energy savings predicted by the procedure.