SUBCHAPTER 7
LOW-RISE RESIDENTIAL BUILDINGS – MANDATORY FEATURES AND DEVICES

SECTION 150 – MANDATORY FEATURES AND DEVICES

Any new construction in a low-rise residential building shall meet the requirements of this Section.

(a) **Ceiling Insulation**. The opaque portions of ceilings separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:

1. Ceilings shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater for the insulation alone.

   ALTERNATIVE to Section 150 (a) 1: Insulation which is not penetrated by framing members may meet an R-value equivalent to installing R-19 insulation between wood-framing members and accounting for the thermal effects of framing members.

2. The weighted average U-factor of ceilings shall not exceed the U-factor that would result from installing R-19 insulation between wood-framing members in the entire ceiling and accounting for the effects of framing members.

(b) **Loose-fill Insulation**. When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled R-value.

(c) **Wall Insulation**. The opaque portions of frame walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:

1. Wood-framed walls shall be insulated between framing members with insulation having an installed thermal resistance of R-13 or greater. Framed foundation walls of heated basements or heated crawl spaces shall be insulated above the adjacent outside ground line with insulation having an installed thermal resistance of at least R-13.

   ALTERNATIVE to Section 150 (c) 1: Insulation which is not penetrated by framing members may meet an R-value equivalent to installing R-13 insulation between wood-framing members and accounting for the thermal effects of framing members.

2. The weighted average U-factor of walls shall not exceed the U-factor that would result from installing R-13 insulation between wood-framing members and accounting for the effects of framing members.

3. Bay Window roofs and floors shall be insulated to meet the wall insulation requirements of Package D.[1]

(d) **Raised-floor Insulation.** Raised floors separating conditioned space from unconditioned space shall meet the requirements of either Item 1 or 2 below:

1. Floors shall be insulated between wood-framing members with insulation having an installed thermal resistance of R-13 or greater.

2. The weighted average U-factor of floor assemblies shall not exceed the U-factor that would result from installing R-13 insulation between wood-framing members and accounting for the effects of framing members.

   ALTERNATIVE to Section 150 (d) 1 and 2: Raised floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in TABLE 151-B and TABLE 151-C, a vapor barrier is placed over the entire floor of the crawl space, and vents are fitted with automatically operated louvers that are temperature actuated.

(e) **Installation of Fireplaces, Decorative Gas Appliances and Gas Logs**

1. If a masonry or factory-built fireplace is installed, it shall have the following:

A. Closeable metal or glass doors covering the entire opening of the firebox;

B. A combustion air intake to draw air from the outside of the building directly into the firebox, which is at least six square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device; and

EXCEPTION to Section 150 (e) 1 B: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

C. A flue damper with a readily accessible control.

EXCEPTION to Section 150 (e) 1 C: When a gas log, log lighter, or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions .

2. Continuous burning pilot lights and the use of indoor air for cooling a firebox jacket, when that indoor air is vented to the outside of the building, are prohibited.

(f) **Air Retarding Wrap**. If an air retarding wrap is installed to meet the requirements of Section 151, it shall meet the requirements specified in the Residential ACM Manual.

(g) **Vapor Barriers**. In Climate Zones 14 and 16 shown in FIGURE 101-A, a vapor barrier shall be installed on the conditioned space side of all insulation in all exterior walls, unvented attics, and unvented crawl spaces to protect insulation from condensation.

If a building has a control ventilation crawl space, a vapor barrier shall be placed over the earth floor of the crawl space to reduce moisture entry and protect insulation from condensation, as specified in the alternative to Section 150 (d).

(h) **Space-conditioning Equipment.**

1. **Building cooling and heating loads.**

Building heating and cooling loads shall be determined using a method based on any one of the following:

A. The ASHRAE Handbook, Equipment Volume, Applications Volume, and Fundamentals Volume, or

B. The SMACNA Residential Comfort System Installation Standards Manual, or

C. The ACCA Manual J.

The cooling and heating loads are two of the criteria that shall be used for equipment sizing and selection.

NOTE: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC. The furnace output capacity and other specifications are published in the commission's directory of certified equipment or other directories approved by the commission.

2. **Design conditions.**

For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 70°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Joint Appendix II, which is based on data from the ASHRAE Climatic Data for Region X, The outdoor design temperatures for heating shall be no lower than the Heating Winter Median of Extremes values. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

(i) ~~**Setback**~~ **Thermostats** – All thermostats shall meet the requirements of Section 112(c).~~heating and/or cooling systems other than wood stoves shall have an automatic thermostat with a clock mechanism or other setback mechanism approved by the executive director that shuts the system off during periods of nonuse and that allows the building occupant to automatically set back the thermostat set points for at least two periods within 24 hours. Setback thermostats for heat pumps shall meet the requirements of Section 112 (b).~~

~~**EXCEPTION to Section 150(i):** Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, room air conditioners, and room air conditioner heat pumps need not comply with this requirement. Additionally, room air conditioner heat pumps need not comply with Section 112 (b). The resulting increase in energy~~

~~use due to elimination of the setback thermostat shall be factored into the compliance analysis in accordance with a method prescribed by the executive director.~~

(j) **Water System Pipe and Tank Insulation and Cooling Systems Line Insulation.**

1. **Storage tank insulation.**

   A. Storage gas water heaters with an energy factor < 0.58 shall be externally wrapped with insulation having an installed thermal resistance of R-12 or greater.

   B. Unfired hot water tanks, such as storage tanks and backup storage tanks for solar water-heating systems, shall be externally wrapped with insulation having an installed thermal resistance of R-12 or greater or have internal insulation of at least R-16 and a label on the exterior of the tank showing the insulation R-value.

2. **Water piping and cooling system line insulation thickness and conductivity**. Piping, whether buried or unburied, for recirculating sections of domestic hot water systems; piping from the heating source to the storage tank for an indirect-fired domestic water-heating system; the first five feet of hot and cold water pipes from the storage tank for nonrecirculating systems; and cooling system lines shall be thermally insulated as specified in Subsection A or B. Piping for steam and hydronic heating systems or hot water systems with pressure above 15 psig shall meet the requirements in TABLE 123-A.

   A. For insulation with conductivity in the range shown in TABLE 150-A for the applicable fluid temperature range, the insulation shall have the applicable thickness shown in TABLE 150-B.

   B. For insulating with an alternate material with conductivity outside the range shown in TABLE 150-A for the applicable fluid temperature range, the insulation shall have a minimum thickness as calculated by EQUATION 150-A .

EQUATION 150-A — INSULATION THICKNESS

$$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

WHERE:

T	=	Minimum insulation thickness for alternate material with conductivity *K*, inches.
PR	=	Pipe actual outside radius, inches.
T	=	Insulation thickness for the applicable system from TABLE 150-B, inches.
K	=	Conductivity of alternate material at the mean rating temperature indicated in TABLE 150-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.
k	=	The lower value of the conductivity range listed in TABLE 150-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

EXCEPTION 1 to Section 150 (j) 2: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

EXCEPTION 2 to Section 150 (j) 2: Piping that serves process loads, gas piping, cold domestic water piping, condensate drains, roof drains, vents, or waste piping.

EXCEPTION 3 to Section 150 (j) 2: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing. Insulation shall butt securely against all framing members.

EXCEPTION 4 to Section 150 (j) 2: Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with the Insulation Installation Quality compliance option as specified by the Residential ACM Manual.

EXCEPTION 5 to Section 150 (j) 2: Piping installed in attics with a minimum of four inches of attic insulation on top of the piping shall not be required to have pipe insulation.

NOTE: Where the executive director approves a water heater calculation method for a particular water heating recirculation system, piping insulation requirements are those specified in the approved calculation method.

3. **Insulation Protection.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind including but not limited to the following:

   A. Insulation exposed to weather shall be suitable for outdoor service; e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

   B. Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

4. Solar water-heating systems and/or collectors shall be certified by the Solar Rating and Certification Corporation.

(k) **Residential Lighting**.

1. **High Efficacy Luminaires**. ~~High Efficacy Luminaires for residential lighting shall contain only high efficacy lamps and shall not contain a medium screw base socket (E24/E26).~~= A high efficacy ~~lamp~~ luminaire has an ~~lamp~~ efficacy that is no lower than the efficacies contained in TABLE 150-C and is not a low efficacy luminaires as specified by Section 150(k)2. ~~Ballasts for lamps rated 13 Watts or greater shall be electronic and shall have an output frequency no less than 20 kHz.~~[2]

   EXCEPTION 1 to Section 150 (k) 1: High intensity discharge (HID) luminaires containing hardwired ~~electromagnetic~~ ballasts ~~in~~ and HID rated medium screw base sockets shall be considered high efficacy luminaires ~~for the purposes of meeting Section 150 (k) 6,~~ provided they meet the efficacies contained in TABLE 150-C.[3]

   EXCEPTION 2 to Section 150 (k) 1: To qualify as high efficacy, self-ballasted high intensity discharge reflector lamps shall have a minimum lamp efficacy within 2 lumens per watt of the minimum lamp efficacies in TABLE 150-C.[4]

   ~~**NOTE:** To determine the minimum lamp efficacy category only the watts of the lamp (not the ballast) are to be considered.~~[5]

2. **Low Efficacy Luminaires.** A low efficacy luminaire is any luminaire that does not qualify as high efficacy as specified by Section 150(k)1, or any of the following regardless of the efficacy: [6]

   A. Contains a medium screw base socket (E24/E26) or other line-voltage socket or an line-voltage lamp holder; or[7]

      EXCEPTION TO Section 150 (k) 2 (A): A Luminaire with a factory installed GU-24 lamp holder may be classified as high efficacy provided that it meets all of the following requirements:

      i. is not a recessed downlight that is rated to be used with compact fluorescent lamps; and

      ii. does not contain any other type of line-voltage socket or lamp holder; and

      iii. the manufacturer does not make available adaptors or modular components for the luminaire which convert the GU-24 lamp holder to any other type of socket or lamp holder; and

      iv. is rated, as specified by UL 1598, for use only with lamps or LED lighting systems meeting the efficacies contained in TABLE 150-C, as listed on a permanent, pre-printed, factory-installed label on the luminaire housing.[8]

   B. Low voltage incandescent lighting; or

   C. Track lighting or other lighting systems which allow the addition or relocation of luminaires without altering the wiring of the system; or

   D. Lighting systems which have modular components that allow conversion between screw-based and pin-based sockets without changing the luminaires' housing or wiring; or [9]

E. Blank electrical boxes installed in ceilings.[10]

3. **Luminaire Wattage**. The wattage of permanently installed luminaires shall be determined as specified by Section130(e) or by a method approved by the Executive Director. In residential kitchens the wattage of blank electrical boxes installed in ceilings shall be determined by the available volt-ampere (VA) capacity of the branch circuit feeding the blank electrical box.[11]

4. **Electronic Ballasts.** Ballasts for fluorescent lamps rated 13 Watts or greater shall be electronic and shall have an output frequency no less than 20 kHz.[12]

5. **Night Lights.** Permanently installed night lights and night lights integral to a permanently installed luminaire or exhaust fan shall contain only high efficacy lamps meeting the minimum efficacies contained in Table 150-C and shall not contain a line-voltage socket or line-voltage lamp holder. Indicator lights that are integral to lighting controls shall comply with Section 119(b).[13]

6. **Switching Devices and Controls**.[14]

A. All permanently installed high efficacy luminaires shall be switched separately from low efficacy luminaires.

B. All exhaust fans shall be switched separately from lighting system(s).

C. All permanently installed luminaires shall be switched with readily accessible controls that permit the luminaires to be manually switched on and off.

D. All lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.[15]

E. No controls, in which a circuit is controlled by more than one switch, shall override a dimmer setting or manual-on occupant sensor that has been installed to comply with Section 150(k). The dimmer or manual-on occupant sensor shall comply with Section 119(k)4.

F. Manual-on occupant sensors, motion sensors, and dimmers installed to comply with Section 150(k) shall comply with the applicable provisions of Section119.

G. In rooms other than kitchens, two switch wires shall be provided to blank electrical boxes that have been installed for luminaires or ceiling fans.[16]

~~2**Lighting in Kitchens.** Permanently installed luminaires in kitchens shall be high efficacy luminaires.~~

~~**EXCEPTION to Section 150 (k) 2** Up to 50 percent of the total rated wattage of permanently installed luminaires in kitchens may be in luminaires that are not high efficacy luminaires, provided that these luminaires are controlled by switches separate from those controlling the high efficacy luminaires. The wattage of high efficacy luminaires shall be the total nominal rated wattage of the installed high efficacy lamp(s). The wattage of luminaires shall be determined as specified by Section 130 (e)~~.[17]

7. **Lighting in Kitchens.** A minimum of 50 percent of the total rated wattage of permanently installed lighting in kitchens shall be high efficacy.

EXCEPTION 1 to Section 150 (k) 7: Up to 50 watts for dwelling units less than or equal to 2,500 ft² or 100 watts for dwelling units larger than 2,500 ft² may be exempt from the 50% high efficacy requirement when the following conditions are met:

a. All low efficacy luminaires in the kitchen are controlled by a manual-on occupant sensor, dimmer, energy management control system (EMCS), or a multi-scene programmable control system.

b. All permanently installed luminaires in garages, laundry rooms, closets greater than 70 square feet, and utility rooms are high efficacy and are controlled by a manual-on occupant sensor.

NOTE: For the purpose of this requirement, kitchen lighting includes all permanently installed lighting in the kitchen except for lighting that is internal to cabinets. Lighting in areas adjacent to the kitchen, including but not limited to dining and nook areas, are considered kitchen lighting if they are not separately switched from kitchen lighting.

8. **Lighting internal to cabinets.** Permanently installed lighting that is internal to cabinets shall use no more than 20 watts of power per linear foot of illuminated cabinet.[18]

~~3~~9. **Lighting in Bathroom, Garages, Laundry Rooms, Closets, and Utility Rooms.** Permanently installed luminaires in bathrooms, attached and detached garages, laundry rooms, closets and utility rooms shall be high efficacy luminaires.[19]

EXCEPTION 1 to Section 150 (k) ~~3~~9: Permanently installed low efficacy luminaires ~~that are not high efficacy~~ shall be allowed provided that they are controlled by ~~an~~ a manual-on occupant sensor(s) certified to comply with Section 119 (k~~d~~). ~~Such motion sensors shall not have a control that allows the luminaire to be turned on automatically or that has an override allowing the luminaire to be always on.~~[20]

EXCEPTION 2 to Section 150(k)9: Permanently installed low efficacy luminaires shall be allowed in closets less than 70 square feet.[21]

~~4~~10. **Lighting other than in Kitchens, Bathrooms, Garages, Laundry Rooms, Closets, and Utility Rooms.** Permanently installed luminaires located in rooms or areas other than in kitchens, bathrooms, garages, laundry rooms, closets, and utility rooms shall be high efficacy luminaires.[22]

EXCEPTION 1 to Section 150 (k) ~~4~~10: Permanently installed low efficacy luminaires ~~that are not high efficacy luminaires~~ shall be allowed provided they are controlled by either a dimmer switch that complies with Section 119(k).[23]

~~**EXCEPTION 2 to Section 150 (k) 410:** Permanently installed low efficacy luminaires that are not high efficacy shall be allowed provided that they are~~ or ~~controlled~~ by ~~an~~ a Manual-on occupant sensor(s) ~~certified to comply~~that complies with the applicable provisions of Section 119. ~~(dk). Such motion sensors shall not have a control that allows the luminaire to be turned on automatically or that has an override allowing the luminaire to be always on.~~[24]

EXCEPTION 2 to Section 150 (k) 10: Lighting in detached storage buildings less than 1000 square feet located on a residential site is not required to comply.[25]

~~**EXCEPTION 3 to Section 150 (k) 4:** Permanently installed luminaires that are not high efficacy luminaires shall be allowed in closets less than 70 square feet.~~[26]

~~**NOTE:** Lighting in areas adjacent to the kitchen, including but not limited to dining and nook areas, are considered kitchen lighting if they are not separately switched from kitchen lighting.~~[27]

~~5~~11. **Recessed Luminaires in Insulated Ceilings.** Luminaires recessed into insulated ceilings shall: ~~be approved for zero clearance insulation cover (IC) by Underwriters Laboratories or other testing/rating laboratories recognized by the International Conference of Building Officials, and shall include a label certifying air tight (AT) or similar designation to show air leakage less than 2.0 CFM at 75 Pascals (or 1.57 lbs/ft^2) when tested in accordance with ASTM E283, and shall be sealed with a gasket or caulk between the housing and ceiling.~~[28]

A. Be listed for zero clearance insulation contact (IC) by Underwriters Laboratories or other testing/rating laboratories recognized by the International Code Council (ICC), and

B. Have a label that certifies that the luminaire is airtight with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283, and

EXCEPTION to Section 150 (k) (11) (B): An exhaust fan housing shall have a label that certifies that the housing is airtight with air leakage less than 2.0 CFM at 25 Pascals, when tested in accordance with ASTM E283 with the duct connector blocked. If the exhaust fan contains an integral lighting system, the lighting system shall comply with all applicable lighting requirements in Section 150(k).[29]

C. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and shall have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk.[30]

D. For luminaires with ballasts to qualify as high efficacy for compliance with Section 150(k), the ballasts shall comply with Section 119(n).[31]

E. Allow ballast maintenance and replacement to be readily accessible to building occupants from below the ceiling without requiring the cutting of holes in the ceiling.[32]

NOTE: Luminaires recessed into ceilings between conditioned floors of a multistory building where no insulation is installed in the cavity between the floors are not required to comply with Section 150(k)11.

~~6~~12. **Outdoor Lighting.** Luminaires providing outdoor lighting and permanently mounted to a residential building or to other buildings on the same lot shall be high efficacy luminaires.

EXCEPTION 1 to Section 150 (k) ~~6~~12: Permanently installed outdoor low efficacy luminaires ~~that are not high efficacy~~ shall be allowed provided that they are controlled by a manual on/off switch, a motion sensor not having an override or bypass switch that disables the motion sensor, and one of the following methods: ~~a motion sensor(s) with integral photocontrol certified to comply with Section 119 (d).~~[33]

A. Photocontrol not having an override or bypass switch that disables the photocontrol; or

B. Astronomical time clock not having an override or bypass switch that disables the astronomical time clock; or

C. Energy management control system (EMCS) not having an override or bypass switch that allows the luminaire to be always on.

EXCEPTION 2 to Section 150 (k)12: Outdoor luminaires used to comply with Exception 1 to Section 150(k)(12) may be controlled by a temporary override switch which bypasses the motion sensing function for up to six hours provided that the override switch automatically reactivates the motion sensor.[34]

EXCEPTION ~~2~~ 3 to Section 150 (k) ~~6~~12: Permanently installed luminaires in or around swimming pools, water features, or other locations subject to Article 680 of the California Electric Code need not be high efficacy luminaires.

13. **Internally illuminated address signs.** Internally illuminated address signs shall comply with Section 148.[35]

~~7~~14. **Parking Lots and Garages.** Lighting for parking lots and carports ~~for~~ with a total of eight or more vehicles per site shall comply with the applicable requirements in Sections 130, 132 and 147. Lighting for parking garages for eight or more vehicles shall comply with the applicable requirements in Sections 130, 131, and 146.

~~8~~15. **Common Areas of Low-rise Residential Buildings.** Permanently installed lighting in the enclosed, non-dwelling spaces of low-rise residential buildings with four or more dwelling units shall be high efficacy luminaires.

EXCEPTION to Section 150 (k) ~~8~~14: Permanently installed low efficacy luminaires ~~that are not high efficacy~~ [36] shall be allowed provided that they are controlled by an occupant sensor(s) certified to comply with Section 119 (d).

(l) **Slab Edge Insulation.** Material used for slab edge insulation shall meet the following minimum specifications:

1. Water absorption rate for the insulation material alone without facings no greater than 0.3 percent when tested in accordance with Test Method A – 24-Hour-Immersion of ASTM C272.
2. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E 96.
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration.

(m) **Air-distribution System Ducts, Plenums, and Fans.**

1. **CMC compliance.** All air-distribution system ducts and plenums, including, but not limited to, mechanical closets and air-handler boxes, shall be installed, sealed and insulated to meet the requirements of the CMC Sections 601, 602, 603, 604, 605 and Standard 6-5, incorporated herein by reference. Portions of supply-air and return-air ducts and plenums shall either be insulated to a minimum installed level of R-4.2 (or any higher level required by CMC Section 605) or be enclosed entirely in conditioned space. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, or other duct-closure system that meets the applicable requirements of UL 181, UL 181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape shall be used.

   Building cavities, support platforms for air handlers, and plenums defined or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

   EXCEPTION to Section 150 (m) 1: The requirements do not apply to ducts and fans integral to a wood heater or fireplace.

2. **Factory-fabricated duct systems.**
   A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections, and splices.
   B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181.
   C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 or UL 181B.
   D. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.
3. **Field-fabricated duct systems.**
   A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants, or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A, or UL 181B.
   B. Mastic sealants and mesh.
      i. Sealants shall comply with UL 181, UL 181A, or UL 181B, and be nontoxic and water resistant.
      ii. Sealants for interior applications shall be tested in accordance with ASTM C 731 and D2202, incorporated herein by reference.
      iii. Sealants for exterior applications shall be tested in accordance with ASTM C 731, C 732, and D 2202, incorporated herein by reference.
      iv. Sealants and meshes shall be rated for exterior use.
   C. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with UL 181, UL 181A, or UL 181B.
   D. Joints and seams of duct systems and their components shall not be sealed with cloth back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.
   E. Drawbands used with flexible duct.
      i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.
      ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.
      iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.
   F. Aerosol-sealant closures.
      i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.
      ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this Section.
4. All duct insulation product R-values shall be based on insulation only (excluding air films, vapor barriers, or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C 518 or ASTM C 177, incorporated herein by reference, and certified pursuant to Section 118.
5. The installed thickness of duct insulation used to determine its R-value shall be determined as follows:
   A. For duct board, duct liner, and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
   B. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
   C. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.
6. Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance R-value for the duct insulation itself (excluding air films, vapor barriers,

or other duct components), based on the tests in Section 150 (m) 4 and the installed thickness determined by Section 150 (m) 5 C.

7. All fan systems, regardless of volumetric capacity, that exhaust air from the building to the outside shall be provided with backdraft or automatic dampers to prevent air leakage.
8. All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.
9. **Protection of Insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.
10. **Porous Inner Core Flex Duct.** Flexible ducts having porous inner cores shall not be used.

(n) **Water Heating Recirculation Loops Serving Multiple Dwelling Units.** Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 113(c)5.

TABLE 150-A PIPE INSULATION CONDUCTIVITY RANGE

FLUID TEMPERATURE RANGE (°F)	**INSULATION MEAN RATING TEMPERATURE** (°F)	**CONDUCTIVITY RANGE** (Btu-inch per hour per square foot per °F)[1]
201 – 250	150	0.27 – 0.30
105 – 201	100	0.24 – 0.28
below 105	75	0.23 – 0.27

[1] Insulation conductivity shall be determined in accordance with ASTM C 335 at the mean temperature listed in TABLE 150-A, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

TABLE 150-B PIPE INSULATION MINIMUM THICKNESS REQUIREMENTS

SYSTEM	**PIPE DIAMETER**	
	Less than or Equal to 2 inches	**Greater than 2 inches**
	INSULATION THICKNESS REQUIRED (in inches)	
Domestic hot water (above 105°F)	1.0	1.5
Hydronic heating supply lines (above 200°F to 250°F)[1]	1.0	2.0
Hydronic heating supply lines (105°F to 200°F)	1.0	1.5
Cooling system refrigerant suction, chilled water and brine lines	0.75	1.0

[1] Steam hydronic heating systems or hot water systems with pressure above 15 psi shall meet the requirements of TABLE 123-A.

TABLE 150-C HIGH EFFICACY ~~LAMP~~LUMINAIRE REQUIREMENTS

Lamp Power Rating for Non-LED Lighting [1], or Luminaire Power Rating for LED Lighting [2]	**Minimum Lamp Efficacy for Non-LED Lighting, or Minimum Luminaire Efficacy for LED Lighting**
5 watts or less	35 lumens per watt[37]
~~15 watts or less~~over 5 watts to 15 watts	40 lumens per watt
over 15 watts to 40 watts	50 lumens per watt
over 40 watts	60 lumens per watt

1. Determine minimum lamp efficacy category for lighting systems which are not LED using only the watts of the lamp (not the ballast). [38]
2. Determine minimum LED luminaire efficacy using the total maximum input wattage for the luminaire as determined by the test procedure in Reference Joint Appendix 6 (JA6) or by a method approved by the Executive Director. [39]

End Notes

The following notes are an explanation of the changes that have been made. These notes are not part of the Standard.

[1] Change was made in response to Farber comment and modified by staff.

[2] The requirement for electronic ballasts was moved from the definition of high efficacy luminaires to another subsection of Section 150(k) to clarify that the intent of the Standards was not to require electronic ballasts only for luminaires classified as high efficacy.

[3] Edited to remove the limitation in the 2005 Standards which does not allows HID luminaires with medium-screw base sockets to qualify as indoor high efficacy lighting systems.

[4] Language added to address lamp manufacturer concerns that the efficacy of reflector HID and reflector compact fluorescent lamps is constrained by the physics inherent in opaque lamp walls. Energy Commission staff worked with Dr. Michael Siminovitch, California Lighting Technology Center, who validated these concerns. Additionally, it is understood that the coefficient of utilization of luminaires with reflector lamps is better than with non-reflector lamps so that some of the light losses typically attributed to the luminaire is improved with the use of reflector lamp.

[5] This language was moved to a footnote in Table 150-C for clarity

[6] This subsection was written for clarity and in response to inquiries. The phrase in Section 150(k), "luminaires that are not high efficacy" has been replaced with the phrase, "low efficacy luminaires" for simplicity.

[7] This language is consistent with similar changes proposed in Section 130(e)1where the 2005 Standards only refer to medium screw-base sockets, but do not specifically addressed other line-voltage sockets, like candelabra base, bayonet base, etc.

[8] This language is consistent with new proposed Section 130(e), which specifically addresses GU-24 sockets. The EPA conducted an effort to develop a new socket that would only be used for high efficacy lighting sources. However, there are currently no state or federal standards limiting the use of GU-24 sockets to only high efficacy. Energy Commission staff has worked with EPA, NEMA, and other stakeholders to help insure that this new socket type continues to be used only for high efficacy lighting sources. There are also requirements written into this proposed subsection to address potentially heat failures, for which NEMA supports not allowing CFL ballasts to use GU-24 bases when inside recessed downlights.

[9] This proposed language is consistent with the 2005 Nonresidential Compliance Manual.

[10] This language is proposed for clarity and in response to inquiries about the use of blank electrical boxes in residential construction. This proposed language is consistent with interpretations of the 2005 Standards which treat "luminaires that are not high efficacy" as being low efficacy luminaires. Therefore, the absence of a high efficacy luminaire will continue to be treated as a low efficacy luminaire.

[11] For clarity, this language was moved from Section 150(k)2 to here.

[12] For clarity, this language was moved from Section 150(k)1.

[13] This additional language was developed in response to the California Lighting Technology Center hybrid hotel vanity light and hybrid outdoor lighting projects, and in response to the PIER study recommending the use of LED hybrid outdoor lighting. A staff analysis has been written to show cost effectiveness.

[14] This language was written for clarity and in response to a number of inquiries.

[15] Language moved from Section 119(g)(1) and moved both here and to Section 130(b) for clarity.

[16] This language is proposed for clarity and in response to inquiries about the use of blank electrical boxes in residential construction. This proposed language is consistent with interpretations of the 2005 Standards which treat "luminaires that are not high efficacy" as being low efficacy luminaires. Therefore, the absence of a high efficacy luminaire will continue to be treated as a low efficacy luminaire.

[17] Added in response to recommendations from custom home lighting designers. The models that were used to develop the 50% high efficacy formula for the 2005 Standards did not consider permanently installed lighting that was used for internally illuminated cabinets. Therefore, it is appropriate to treat lighting for internally illuminated cabinets separately from the other kitchen lighting.

[18] Please see previous footnote. The proposed 20 watts per linear foot of illuminated cabinet was recommended by members of the lighting industry and is intended to represent common practice in the use of low voltage cabinet lighting.

[19] Edited for clarity in response to inquiries

[20] Edited for clarity.

[21] For clarity, moved to here from Exception 3 to Section 150(k)4.

[22] Edited for clarity

[23] Edited for clarity

[24] Edited for clarity

[25] Added for clarity and in response to inquiries about how the application of Section 146(a)(5)(Q) might apply to Section 150(k) in the 2005 Standards. It is clear that Section 146(a)(5)(Q) only applies to Section 146 and does not apply to Section 150(k) at all. This application needs to be similarly addressed and clarified in Section 150(k) to be consistent with industry discussions that occurred during the 2005 Standards rulemaking.

[26] This has been moved to another subsection in Section 150(k) for clarity.

[27] This has been moved to another subsection in Section 150(k) for clarity.

[28] Edited for clarity.

[29] Added in response to inquiries and for clarity. The 2005 residential lighting Standards apply to residential lighting that is integral to exhaust fans. However, Energy Commission staff learned that it is difficult to manufacture and install bathroom exhaust fans which meet the airtight requirements in the 2005 Standards, and learned that these exhaust fans were not considered in the analysis used justify the airtight specifications in the 2005 Standards.. Therefore, representatives from the exhaust fan industry have proposed to allow the testing of air tightness for recessed exhaust fans to be conducted under lower pressures than is required for recessed luminaires. The proposed language here is to use: "to show air leakage less than 2.0 CFM at 25 Pascals," instead of "75 Paacals" as is require for recessed luminaires.

[30] Language taken from the 2005 Residential Compliance Manual has been added here for clarity.

[31] This language has been proposed by Dr. Michael Siminovitch, from the California Lighting Technology Center, in response to the discovery that there is a significant potential for heat failure on some luminaires installed to qualify with the 2005 Standards. Dr. Siminovitch has worked with manufacturers and other stakeholders to come up with these proposed solutions to the current heat failure concerns.

[32] Added for clarity in response to concerns raised by stakeholders about potential costs that consumers will occur for ballast replacements if the ballasts cannot be changed without destroying the ceiling or climbing through the attic.

[33] Edited for clarity in response to inquires and suggestions to allow alternate control options for residential low efficacy outdoor lighting.

[34] Added in response to inquiries, and similar to features supported by Energy Star which allow for temporary override of the outdoor lighting motion sensor.

[35] Added in response to inquires to clarify that address signs shall meet the sign Standards in Section 148 instead of the residential outdoor lighting requirements in Section 150(k). It may not be appropriate for all address signs to be on a motion sensor as required if they are considered a building mounted outdoor luminaire in accordance with Section 150(k).

[36] Edited for clarity.

[37] This additional row has been added to accommodate low wattage LED lighting and to encourage the increased use of lower wattage lamps.

[38] This note has been moved from another part of Section 150(k) and expanded to address the increased use of LED lighting systems. For simplicity in the 2005 Standards, only the initial rated lumens and initial rated lamp watts were considered because it was assumed that only fluorescent lamps with electronic ballasts were going to be used as high efficacy lighting sources, and it is understood that power losses for electronic ballasts are insignificant. These same assumptions do not apply to LED lighting systems.

[39] There are currently no nationally recognized standards for the testing and classification of solid state lighting (SSL) systems, also known as light emitting diodes (LED). Energy Commission staff has worked with the IESNA Solid State Lighting Committee, and other interested parties, to develop this proposed language in Table 150-C, as well as SSL language proposed for Section 130(e). The IESNA SSL Committee is working on a new proposed document titled "LM-79," which is anticipated to be adopted by IESNA sometime in 2007. It is the intent of the proposed language in Section 130(e) and this language in Table 150-C to be consistent with, and to not be in conflict with the intent of LM-79.