

SUBCHAPTER 7

LOW-RISE RESIDENTIAL BUILDINGS— MANDATORY FEATURES AND DEVICES

SECTION 150.0 MANDATORY FEATURES AND DEVICES

Low-rise residential buildings shall comply with the applicable requirements of Sections 150(a) through 150.0(r).

NOTE: The requirements of Sections 150.0(a) through 150.0(r) apply to newly constructed buildings. Sections 150.2(a) and 150.2(b) specify which requirements of Sections 150.0(a) through 150.0(r) also apply to additions or alterations.

(a) **Ceiling and rafter roof insulation.** The opaque portions of ceilings and roofs separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Items 1 through 3 below:

1. Shall be insulated to achieve a weighted average *U*-factor not exceeding U-0.043 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-22 or greater for the insulation alone. For vented attics, the mandatory insulation shall be installed at the ceiling level; for unvented attics, the mandatory insulation shall be placed at either ceiling or roof level; and

Exception to Section 150.0(a)1: Ceilings and rafter roofs in an alteration shall be insulated to achieve a weighted average *U*-factor not exceeding 0.054 or shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater.

2. Attic access doors shall have permanently attached insulation using adhesive or mechanical fasteners. The attic access shall be gasketed to prevent air leakage; and
3. Insulation shall be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.

(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.** Opaque portions of above grade walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of Items 1, 2, 3 and 4 below:

1. 2 × 4 inch framing shall have an overall assembly *U*-factor not exceeding U-0.102, equivalent to an installed *R*-value of 13 in a wood framed assembly.

Exception to Section 150.0(c)1: Existing walls already insulated to a *U*-factor not exceeding U-0.110 or already insulated between framing members with insulation having an installed thermal resistance of R-11 or greater.

2. 2 × 6 inch or greater framing shall have an overall assembly *U*-factor not exceeding U-0.074 or an installed *R*-value of 19 in a wood framed assembly.

3. Opaque nonframed assemblies shall have an overall assembly *U*-factor not exceeding U-0.102, equivalent to an installed *R*-value of 13 in a wood-framed assembly.

4. Bay or bow window roofs and floors shall be insulated to meet the wall insulation requirements of Table 150.1-A.

(d) **Raised-floor insulation.** Raised floors separating conditioned space from unconditioned space or ambient air shall have an overall assembly *U*-factor not exceeding U-0.037 or an installed *R*-value of 19 or greater in a wood-framed assembly.

Exception to Section 150.0(d): A building with a controlled ventilation or unvented crawlspace may omit raised floor insulation if all of the following are met:

- i. The foundation walls are insulated to meet the wall insulation minimums as shown in Table 150.1-A; and
- ii. A Class I or Class II vapor retarder is placed over the entire floor of the crawl space; and
- iii. Vents between the crawlspace and outside air are fitted with automatically operated louvers that are temperature actuated; and
- iv. The requirements in Reference Residential Appendix RA4.5.1.

(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. Closable metal or glass doors covering the entire opening of the firebox; and
- B. A combustion air intake to draw air from the outside of the building, which is at least 6 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 150.0(e)1B: 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 150.0(e)1C: 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) **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 E96.
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration.
4. Insulation for a heated slab floor shall meet the requirements of Section 110.8(g).

(g) **Vapor retarder.**

1. In Climate Zones 1–16, the earth floor of unvented crawl space shall be covered with a Class I or Class II vapor retarder. This requirement shall also apply to controlled ventilation crawl space for buildings complying with the Exception to Section 150.0(d).
2. In Climate Zones 14 and 16, a Class I or Class II vapor retarder shall be installed on the conditioned space side of all insulation in all exterior walls, vented attics and unvented attics with air-permeable insulation.

(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 68°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, 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.

3. **Outdoor condensing units.**

A. **Clearances.** Installed air conditioner and heat pump outdoor condensing units shall have a clearance of at least five (5) feet (1.5 meters) from the outlet of any dryer vent.

B. **Liquid line drier.** Installed air conditioner and heat pump systems shall be equipped with liquid line filter driers if required, as specified by manufacturer’s instructions.

4. **Central forced-air heating furnaces.**

A. **Temperature rise.** Central forced-air heating furnace installations shall be configured to operate in conformance with the furnace manufacturer’s maximum inlet-to-outlet temperature rise specifications.

(i) **Thermostats.** All unitary heating or cooling systems, including heat pumps, not controlled by a central energy management control system (EMCS) shall have a setback thermostat, as specified in Section 110.2(c).

(j) **Water system piping and insulation for piping tanks and cooling systems lines.**

1. **Storage tank insulation.** 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 shall be insulated to the thicknesses as follows:

- A. All domestic hot water system piping conditions listed below, whether buried or unburied, must be insulated and the insulation thickness shall be selected based on the conductivity range in Table 120.3-A and the insulation level shall be selected from the fluid temperature range based on the thickness requirements in Table 120.3-A:
 - i. The first 5 feet (1.5 meters) of hot and cold water pipes from the storage tank.
 - ii. All piping with a nominal diameter of $\frac{3}{4}$ inch (19 millimeter) or larger.
 - iii. All piping associated with a domestic hot water recirculation system regardless of the pipe diameter.
 - iv. Piping from the heating source to storage tank or between tanks.
 - v. Piping buried below grade.
 - vi. All hot water pipes from the heating source to the kitchen fixtures.

B. In addition to insulation requirements, all domestic hot water pipes that are buried below grade must be installed in a water proof and noncrushable casing or sleeve.

C. Pipe for cooling system lines shall be insulated as specified in Subsection A. Distribution piping for steam and hydronic heating systems, shall meet the requirements in Table 120.3-A.

Exception 1 to Section 150.0(j)2: Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2.

Exception 2 to Section 150.0(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 150.0(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 150.0(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 quality insulation installation (QII) as specified in the Reference Residential Appendix RA3.5.

Exception 5 to Section 150.0(j)2: Piping installed in attics with a minimum of 4 inches (10 cm) 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 particular water heating recirculation system, piping insulation requirements are those specified in the approved calculation method.

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

A. Insulation exposed to weather shall be installed with a cover suitable for outdoor service including but not limited to aluminum, sheet metal, painted canvas, or plastic cover. The cover shall be 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 have a Class I or Class II vapor retarder.

(k) **Residential lighting.**

1. **Luminaire requirements.**

A. **Luminaire efficacy.** All installed luminaires shall be high-efficacy in accordance with Table 150.0-A.

B. **Blank electrical boxes.** The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, vacancy sensor control, or fan speed control.

C. **Recessed downlight luminaires in ceilings.** Luminaires recessed into ceilings shall meet all of the following requirements:

i. Be listed, as defined in Section 100.1, for zero clearance insulation contact (IC) by Underwriters Laboratories or other nationally recognized testing/rating laboratory; and

ii. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. An exhaust fan housing shall not be required to be certified airtight; and

iii. 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; and

iv. For luminaires with hardwired ballasts or drivers, allow ballast or driver maintenance and replacement to be readily accessible to building occupants from below the ceiling without requiring the cutting of holes in the ceiling; and

v. Shall not contain screw base sockets; and

vi. Shall contain light sources that comply with References Joint Appendix JA8, including the elevated temperature requirements, and that are marked “JA8-2016-E” as specified in Reference Joint Appendix JA8.

D. **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.

E. **Night lights.** Permanently installed night lights and night lights integral to installed luminaires or exhaust fans shall be rated to consume no more than five watts of power per luminaire or exhaust fan as determined in accordance with Section 130.0(c). Night lights shall not be required to be controlled by vacancy sensors.

F. **Lighting integral to exhaust fans.** Lighting integral to exhaust fans shall meet the applicable requirements of Section 150(k).

Exception to Section 150.0(k)1F: Lighting installed by the manufacturer in kitchen exhaust hoods.

G. **Screw based luminaires.** Screw based luminaires shall meet all of the following requirements:

i. The luminaires shall not be recessed downlight luminaires in ceilings; and

- ii. The luminaires shall contain lamps that comply with Reference Joint Appendix JA8; and
- iii. The installed lamps shall be marked with “JA8-2016” or “JA8-2016-E” as specified in Reference Joint Appendix JA8.

Exception to Section 150.0(k)1G: Luminaires with hard-wired ballasts for high intensity discharge lamps.

H. Enclosed luminaires. Light sources that are not marked “JA8-2016-E” shall not be installed in enclosed luminaires.

2. Interior lighting switching devices and controls.

A. All forward phase cut dimmers used with LED light sources shall comply with NEMA SSL 7A.

B. Exhaust fans shall be switched separately from lighting system.

Exception to Section 150.0(k)2B: Lighting integral to an exhaust fan may be on the same switch as the fan provided the lighting can be switched OFF in accordance with the applicable provisions in Section 150.0(k)2 while allowing the fan to continue to operate for an extended period of time.

C. Luminaires shall be switched with readily accessible controls that permit the luminaires to be manually switched ON and OFF.

D. Lighting controls and equipment shall be installed in accordance with the manufacturer’s instructions.

E. No controls shall bypass a dimmer or vacancy sensor function where that dimmer or vacancy sensor has been installed to comply with Section 150.0(k).

F. Lighting controls shall comply with the applicable requirements of Section 110.9.

G. An energy management control system (EMCS) may be used to comply with dimmer requirements in Section 150.0(k) if at a minimum it provides the functionality of a dimmer in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.

H. An energy management control system (EMCS) may be used to comply with vacancy sensor requirements in Section 150.0(k) if at a minimum it provides the functionality of a vacancy sensor in accordance with Section 110.9, meets the installation certificate requirements in Section 130.4, the EMCS requirements in Section 130.5(f), and complies with all other applicable requirements in Section 150.0(k)2.

I. A multiscene programmable controller may be used to comply with dimmer requirements in Section 150.0(k) if at a minimum it provides the functionality of a dimmer in accordance with Section 110.9, and complies with all other applicable requirements in Section 150.0(k)2.

J. In bathrooms, garages, laundry rooms, and utility rooms, at least one luminaire in each of these spaces shall be controlled by a vacancy sensor.

K. Dimmers or vacancy sensors shall control all luminaires required to have light sources compliant with Reference Joint Appendix JA8.

Exception 1 to Section 150.0(k)2K: Luminaires in closets less than 70 square feet.

Exception 2 to Section 150.0(k)2K: Luminaires in hallways.

L. Undercabinet lighting shall be switched separately from other lighting systems.

3. Residential outdoor lighting. In addition to meeting the requirements of Section 150.0(k)1A, luminaires providing residential outdoor lighting shall meet the following requirements, as applicable:

A. For single-family residential buildings, outdoor lighting permanently mounted to a residential building or to other buildings on the same lot shall meet the requirement in Item i and the requirements in either Item ii or Item iii:

i. Controlled by a manual ON and OFF switch that does not override to ON the automatic actions of Items ii or iii below; and

ii. Controlled by photocell and motion sensor. Controls that override to ON shall not be allowed unless the override automatically reactivates the motion sensor within 6 hours; or

iii. Controlled by one of the following methods:

a. Photocontrol and automatic time switch control. Controls that override to ON shall not be allowed unless the override shall automatically return the photocontrol and automatic time switch control to its normal operation within 6 hours; or

b. Astronomical time clock. Controls that override to ON shall not be allowed unless the override shall automatically return the astronomical clock to its normal operation within 6 hours and which is programmed to automatically turn the outdoor lighting OFF during daylight hours; or

c. Energy management control system which meets all of the following requirements:

At a minimum provides the functionality of an astronomical time clock in accordance with Section 110.9; meets the installation certification requirements in Section 130.4; does not have an override or bypass switch that allows the luminaire to be always ON; and, is programmed to automatically turn the outdoor lighting OFF during daylight hours.

B. For low-rise multifamily residential buildings, outdoor lighting for private patios, entrances, balconies and porches; and outdoor lighting for residential

parking lots and residential carports with less than eight vehicles per site shall comply with one of the following requirements:

- i. Shall comply with Section 150.0(k)3A; or
- ii. Shall comply with the applicable requirements in Sections 110.9, 130.0, 130.2, 130.4, 140.7 and 141.0.

C. For low-rise residential buildings with four or more dwelling units, outdoor lighting not regulated by Section 150.0(k)3B or 150.0(k)3D shall comply with the applicable requirements in Sections 110.9, 130.0, 130.2, 130.4, 140.7 and 141.0.

D. Outdoor lighting for residential parking lots and residential carports with a total of eight or more vehicles per site shall comply with the applicable requirements in Sections 110.9, 130.0, 130.2, 130.4, 140.7 and 141.0.

4. **Internally illuminated address signs.** Internally illuminated address signs shall:

- A. Comply with Section 140.8; or
- B. Shall consume no more than 5 watts of power as determined according to Section 130.0(c).

5. **Residential garages for eight or more vehicles.** Lighting for residential parking garages for eight or more vehicles shall comply with the applicable requirements for nonresidential garages in Sections 110.9, 130.0, 130.1, 130.4, 140.6 and 141.0.

6. **Interior common areas of low-rise multifamily residential buildings.**

A. In a low-rise multifamily residential building where the total interior common area in a single building equals 20 percent or less of the floor area, permanently installed lighting for the interior common areas in that building shall be high efficacy luminaires and controlled by an occupant sensor.

B. In a low-rise multifamily residential building where the total interior common area in a single building equals more than 20 percent of the floor area, permanently installed lighting in that building shall:

- i. Comply with the applicable requirements in Sections 110.9, 130.0, 130.1, 140.6 and 141.0; and
- ii. Lighting installed in corridors and stairwells shall be controlled by occupant sensors that reduce the lighting power in each space by at least 50 percent. The occupant sensors shall be capable of turning the light fully on and off from all designed paths of ingress and egress.

(l) **Reserved.**

(m) **Air-distribution and ventilation 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 601.0, 602.0, 603.0, 604.0, 605.0 and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, incorporated herein by reference. Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to a minimum installed level of R-6.0 (or any higher level required by CMC Section 605) or a minimum installed level of R-4.2 when entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8. 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, UL181A 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 designed 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 150.0(m)1: 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, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

B. All pressure-sensitive tapes, heat-activated tapes and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and 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 and UL 181B.

B. Mastic sealants and mesh.

- i. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 181B, and be nontoxic and water resistant.
 - ii. Sealants for interior applications shall be tested in accordance with ASTM C731 and D2202 incorporated herein by reference.
 - iii. Sealants for exterior applications shall be tested in accordance with ASTM C731, C732 and D2202, incorporated herein by reference.
 - iv. Sealants and meshes shall be rated for exterior use.
- C. Pressure-sensitive tape. Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and 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. **Duct insulation R-value ratings.** All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor retarder or other duct components) and tested *C*-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C518 or ASTM C177, incorporated herein by reference, and certified pursuant to Section 110.8.
5. **Duct insulation thickness.** 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. **Duct labeling.** 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 retarders or other duct components), based on the tests in Section 150.0(m)4 and the installed thickness determined by Section 150.0(m)5C.
7. **Backdraft dampers.** All fan systems, regardless of volumetric capacity, that exchange air between the building conditioned space and the outside of the building shall be provided with backdraft or automatic dampers to prevent unintended air leakage through the fan system when the fan system is not operating.
8. **Gravity ventilation dampers.** 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.
11. **Duct system sealing and leakage testing.** When space conditioning systems utilize forced air duct systems to supply conditioned air to an occupiable space, the ducts shall be sealed, as confirmed through field verification and diagnostic testing, in accordance with all applicable procedures specified in Reference Residential Appendix RA3.1, and the leakage compliance criteria specified in Reference Residential Appendix Table RA3.1-2, and conforming to one of the following subsections A, B, or C as applicable:
- A. For single-family dwellings and townhouses with the air-handling unit installed and the ducts connected directly to the air handler, the total leakage of the duct system shall not exceed 5 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1.
 - B. For single-family dwellings and townhouses at the rough-in stage of construction prior to installation of the dwelling's interior finishing:
 - i. Air-handling unit installed.
 - If the air-handling unit is installed and the ducts are connected directly to the air handler, the total leakage of the duct system shall not exceed 6 percent of the nominal system air handler air-

flow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.1 and RA3.1.4.3.3.

ii. Air-handling unit not yet installed.

If the air-handling unit is not yet installed, the total leakage of the duct system shall not exceed 4 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Sections RA3.1.4.3.2, RA3.1.4.3.2.2 and RA3.1.4.3.3.

C. For multifamily dwellings with the air-handling unit installed and the ducts connected directly to the air handler, regardless of duct system location,

i. The total leakage of the duct system shall not exceed 12 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.1, or

ii. The duct system leakage to outside shall not exceed 6 percent of the nominal system air handler airflow as determined utilizing the procedures in Reference Residential Appendix Section RA3.1.4.3.4.

12. **Air filtration.** Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 feet (3 m) in length and through a thermal conditioning component, except evaporative coolers, shall be provided with air filter devices in accordance with the following:

A. **System design and installation.**

i. The system shall be designed to ensure that all recirculated air and all outdoor air supplied to the occupiable space is filtered before passing through the system’s thermal conditioning components.

ii. The system shall be designed to accommodate the clean-filter pressure drop imposed by the system air filter device(s). The design airflow rate and maximum allowable clean-filter pressure drop at the design airflow rate applicable to each air filter device shall be determined.

iii. All system air filter devices shall be located and installed in such a manner as to allow access and regular service by the system owner.

iv. All system air filter device locations shall be labeled to disclose the applicable design airflow rate and the maximum allowable clean-filter pressure drop as determined according to subsection ii above. The labels shall be permanently affixed to the air filter device readily legible, and visible to a person replacing the air filter media.

B. **Air filter media efficiency.** The system shall be provided with air filter media having a designated efficiency equal to or greater than MERV 6 when tested in accordance with ASHRAE Standard 52.2, or a particle size efficiency rating equal to or greater

than 50 percent in the 3.0–10 mm range when tested in accordance with AHRI Standard 680.

C. **Air filter media pressure drop.** The system shall be provided with air-filter media that conforms to the maximum allowable clean-filter pressure drop determined according to Section 150.0(m)12Aii, when tested using ASHRAE Standard 52.2, or as rated using AHRI Standard 680, for the applicable design airflow rate(s) for the system air filter device(s). If the alternative to Section 150.0(m)13B is utilized for compliance, the design clean-filter pressure drop for the system air filter media shall conform to the requirements given in Table 150.0-B or 150.0-C.

D. **Air filter media product labeling.** The system shall be provided with air filter media that has been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 150.0(m)12B and 150.0(m)12C.

13. **Duct system sizing and air filter grille sizing.** Space conditioning systems that utilize forced air ducts to supply cooling to an occupiable space shall:

A. **Static pressure probe.** Have a hole for the placement of a static pressure probe (HSPP), or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location, and labeling of the HSPP or PSPP shall conform to the requirements specified in Reference Residential Appendix RA3.3.1.1 as confirmed by field verification and diagnostic testing; and

Exception to 150.0(m)13A: Systems that cannot conform to the specifications for hole location in Reference Residential Appendix Figure RA3.3-1 shall not be required to provide holes as described in Figure RA3.3-1.

B. **Single zone central forced air systems.** Demonstrate, in every control mode, airflow greater than or equal to 350 CFM per ton of nominal cooling capacity through the return grilles, and an air-handling unit fan efficacy less than or equal to 0.58 W/CFM as confirmed by field verification and diagnostic testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

Exception 1 to Section 150.0(m)13B: Standard ducted systems (without zoning dampers) may comply by meeting the applicable requirements in Table 150.0-B or 150.0-C as confirmed by field verification and diagnostic testing in accordance with the procedures in Reference Residential Appendix Sections RA3.1.4.4 and RA3.1.4.5. The design clean-filter pressure drop requirements of Section 150.0(m)12C for the system air filter device(s) shall conform to the requirements given in Tables 150.0-B and 150.0-C.

Exception 2 to Section 150.0(m)13B: Multispeed compressor systems or variable speed compressor

systems shall verify air flow (cfm/ton) and fan efficacy (Watt/cfm) for system operation at the maximum compressor speed and the maximum air handler fan speed.

Exception 3 to Section 150.0(m)13B: The Executive Director may approve alternate airflow and fan efficacy requirements for small duct high velocity systems.

Exception to Section 150.0(m)13C: Multispeed or variable speed compressor systems, or single speed compressor systems that utilize the performance compliance approach, shall demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 150.0(m)13C by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning, rather than in every zonal control mode.

C. Zonally controlled central forced air systems. Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 CFM per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to 0.58 W/CFM as confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

(n) Water heating system.

1. Systems using gas or propane water heaters to serve individual dwelling units shall include the following components:
 - A. A 120V electrical receptacle that is within 3 feet from the water heater and accessible to the water heater with no obstructions; and
 - B. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and
 - C. A condensate drain that is no more than 2 inches higher than the base of the installed water heater, and allows natural draining without pump assistance; and
 - D. A gas supply line with a capacity of at least 200,000 Btu/hr.
2. Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 110.3(c)5.
3. Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC) or by a listing agency that is approved by the executive director.
4. Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)7.

(o) Ventilation for indoor air quality. All dwelling units shall meet the requirements of ASHRAE Standard 62.2. Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings. Window operation is not a permissible method of providing the whole-building ventilation airflow required in Section 4 of that ASHRAE Standard 62.2. Continuous operation of central forced air system air handlers used in central fan integrated ventilation systems is not a permissible method of providing the whole-building ventilation airflow required in Section 4 of ASHRAE Standard 62.2. Additionally, all dwelling units shall meet the following requirements:

1. Field verification and diagnostic testing.

A. Airflow performance. The whole-building ventilation airflow required by Section 4 of ASHRAE Standard 62.2 shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.

(p) Pool systems and equipment installation. Any residential pool system or equipment installed shall comply with the applicable requirements of Section 114, as well as the requirements listed in this section.

1. Pump sizing and flow rate.

A. All pumps and pump motors installed shall be listed in the Commission’s directory of certified equipment and shall comply with the Appliance Efficiency Regulations.

B. All pump flow rates shall be calculated using the following system equation:

$$H = C \times F^2$$

where:

H is the total system head in feet of water.

F is the flow rate in gallons per minute (gpm).

C is a coefficient based on the volume of the pool:

0.0167 for pools less than or equal to 17,000 gallons.

0.0082 for pools greater than 17,000 gallons.

C. Filtration pumps shall be sized, or if programmable shall be programmed, so that the filtration flow rate is not greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater; and

D. Pump motors used for filtration with a capacity of 1 hp or more shall be multispeed; and

E. Each auxiliary pool load shall be served by either separate pumps, or the system shall be served by a multispeed pump; and

Exception to Section 150.0(p)1E: Pumps if less than 1 hp may be single speed.

F. Multispeed pumps shall have controls which default to the filtration flow rate when no auxiliary pool loads are operating; and

G. For multispeed pumps, the controls shall default to the filtration flow rate setting within 24 hours and shall have an override capability for servicing.

2. **System piping.**

- A. A length of straight pipe that is greater than or equal to at least 4 pipe diameters shall be installed before the pump; and
- B. Pool piping shall be sized so that the velocity of the water at maximum flow for auxiliary pool loads does not exceed 8 feet per second in the return line and 6 feet per second in the suction line; and
- C. All elbows shall be sweep elbows or of an elbow-type that has a pressure drop of less than the pressure drop of straight pipe with a length of 30 pipe diameters.

3. **Filters.** Filters shall be at least the size specified in NSF/ANSI 50 for public pool intended applications.

4. **Valves.** Minimum diameter of backwash valves shall be 2 inches or the diameter of the return pipe, whichever is greater.

(q) **Fenestration products.** Fenestration separating conditioned space from unconditioned space or outdoors shall meet the requirements of either Item 1 or 2 below:

1. Fenestration, including skylight products, must have a maximum *U*-factor of 0.58.

Exception 1 to Section 150.0(q)1: Up to 10 square feet of fenestration area or 0.5 percent of the conditioned floor area, whichever is greater, is exempt from the maximum *U*-factor requirement.

Exception 2 to Section 150.0(q)1: For dual-glazed greenhouse or garden windows, up to 30 square feet of fenestration area is exempt from the maximum *U*-factor requirement.

2. The weighted average *U*-factor of all fenestration, including skylight products shall not exceed 0.58.

(r) **Solar ready buildings.** shall meet the requirements of Section 110.10 applicable to the building project.

**TABLE 150.0-A
CLASSIFICATION OF HIGH-EFFICACY LIGHT SOURCES**

HIGH-EFFICACY LIGHT SOURCES	
Luminaires installed with only the lighting technologies in this table shall be classified as high efficacy	
Light sources in this column, other than those installed in ceiling recessed downlight luminaires, are classified as high efficacy and are not required to comply with Reference Joint Appendix JA8	Light sources in this column shall be certified to the Commission as High Efficacy Light Sources in accordance with Reference Joint Appendix JA8 and be marked as meeting JA8.
1. Pin-based linear or compact fluorescent light sources using electronic ballasts. 2. Pulse-start metal halide. 3. High pressure sodium. 4. GU-24 sockets containing light sources other than LEDs. ^{a, b} 5. Luminaires with hardwired high frequency generator and induction lamp. 6. Inseparable SSL luminaires that are installed outdoors. 7. Inseparable SSL luminaires containing colored light sources that are installed to provide decorative lighting.	8. All light sources in ceiling recessed downlight luminaires. Note that ceiling recessed downlight luminaires shall not have screw bases regardless of lamp type as described in Section 150.0(k)1C. 9. GU-24 sockets containing LED light sources. 10. Any light source not otherwise listed in this table and certified to the Commission as complying with Joint Appendix 8.

Notes:

- a. GU-24 sockets containing light sources such as compact fluorescent lamps and induction lamps.
- b. California Title 20 Section 1605(k)3 does not allow incandescent sources to have a GU-24 base.

**TABLE 150.0-B
RETURN DUCT SIZING FOR SINGLE RETURN DUCT SYSTEMS**

Return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.		
Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12A to disclose the grille’s design airflow rate and a maximum allowable clean-filter pressure drop of 12.5 Pa (0.05 inches water) for the air filter media as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.		
SYSTEM NOMINAL COOLING CAPACITY (Ton)*	MINIMUM RETURN DUCT DIAMETER (inch)	MINIMUM TOTAL RETURN FILTER GRILLE GROSS AREA (inch ²)
1.5	16	500
2.0	18	600
2.5	20	800

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton.

**TABLE 150.0-C
RETURN DUCT SIZING FOR MULTIPLE RETURN DUCT SYSTEMS**

Each return duct length shall not exceed 30 feet and shall contain no more than 180 degrees of bend. If the total bending exceeds 90 degrees, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12A to disclose the grille’s design airflow rate and a maximum allowable clean-filter pressure drop of 12.5 Pa (0.05 inches water) for the air filter media as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

SYSTEM NOMINAL COOLING CAPACITY (Ton)*	RETURN DUCT 1 MINIMUM DIAMETER (inch)	RETURN DUCT 2 MINIMUM DIAMETER (inch)	MINIMUM TOTAL RETURN FILTER GRILLE GROSS AREA (inch ²)
1.5	12	10	500
2.0	14	12	600
2.5	14	14	800
3.0	16	14	900
3.5	16	16	1000
4.0	18	18	1200
5.0	20	20	1500

*Not applicable to systems with nominal cooling capacity greater than 5.0 tons or less than 1.5 tons.