CHAPTER 6

ENERGY CONSERVATION, EFFICIENCY AND ATMOSPHERIC QUALITY

SECTION 601
GENERAL

601.1 Scope. This chapter shall regulate the design, construction, and functional testing of commercial *buildings* and *building sites* for the effective use of energy.

601.2 Intent. The intent of this chapter is to reduce the energy consumption of commercial *buildings* and *building sites*. This chapter is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve reduced energy use. For *historic buildings* and *building sites*, input from the *code official* shall be sought.

601.3 Minimum requirements. Buildings and building sites shall comply with Sections 502.4, 503.2, 504 and 505 of the *Energy Code* regardless of the compliance path chosen.

SECTION 602
ENERGY PERFORMANCE, PEAK POWER

602.1 *Zero energy performance index* (zEPI). RESERVED.

602.2 Compliance paths. New *buildings*, existing *building additions* and *alterations* to existing *buildings* over 70,000 square feet (6500 m) in *total building floor area* or 50,000 square feet (4645 m) for buildings with complex mechanical systems, and their associated *building* sites shall comply with Section 602.2.2. All other *buildings, additions or alterations* shall comply with Section 602.2.1 or 602.2.2.

602.2.1 Prescriptive-based compliance. *Buildings* designed on a prescriptive basis shall comply with the requirements of Sections 604 through 612 of this code.

602.2.2 Performance-based compliance. *Buildings* designed on a performance basis shall comply with Sections 604, 605, 609, 610 and 612 of this code.

602.2.2.1 Minimum performance. The *building* shall be designed and constructed to deliver 18 percent less energy use than that of a baseline building complying with the *Energy Code* and mandatory requirements of this code (documentation required per Section 603). Alternate compliance method: An energy model submitted under an alternate program using ASHRAE 90.1-2007, Appendix G modeling guidelines, showing 26 percent less energy use than a baseline building.

602.2.2.2 Building peak energy demand. RESERVED.

602.2.2.3 Annual direct and indirect CO_2e emissions. RESERVED.

602.2.2.4 Additional mandatory requirements. The following sections are to be included in all performance-based compliance projects when applicable: 606.1.2, 606.1.3, 607.3, 608 and 609.6. These energy measures may not be counted toward the modeled energy savings goal under Section 602.2.2.1.

602.2.3 Outcome based compliance. RESERVED.

602.2.3.1 Maximum energy use. RESERVED.

602.2.3.2 Building peak energy demand. RESERVED.

602.2.3.3 CO_2e emissions. RESERVED.

602.2.4 Energy use intensity (EUI). RESERVED.

602.2.4.1 EUI determination. RESERVED.

602.3 Documentation and verification for alterations to existing buildings. RESERVED.

602.3.1 Determination of energy savings. RESERVED.

602.3.2 Measurement-based compliance. RESERVED.

602.3.3 Third-party certification-based compliance. RESERVED.

SECTION 603
ENERGY USE AND ATMOSPHERIC IMPACTS

603.1 Determination of building annual energy use, peak energy demand. Where *buildings* are designed using the performance-based compliance path in accordance with Section 602.2.2, the methods for calculating and verifying annual energy use, and peak energy demand, shall be in accordance with this section.

603.1.1 Annual energy use. RESERVED.

603.1.2 Documentation procedures. The annual energy use of the *building* and *building site* shall be documented in accordance with Section 506.1 of the *Energy Code, ASHRAE 90.1 Appendix G or L as necessary to meet a third-party verified certification program.*

603.1.3 Annual direct and indirect CO_2e emissions. RESERVED.

603.1.3.1 On-site electricity. RESERVED.

603.1.3.2 On-site nonrenewable fuels. RESERVED.

603.1.4 Annual direct and indirect CO_2e emissions associated with on-site use of fossil fuels and purchased district energy. RESERVED.

603.2 Determination of and compliance with building annual net energy performance and peak net energy demand requirements. RESERVED.

603.2.1 Design. RESERVED.

603.2.2 Construction. RESERVED.

603.2.3 Commissioning. RESERVED.

603.2.4 Annual operations. RESERVED.

603.3 Calculation procedures. The annual energy use of the *building* and *building site* shall be calculated in accordance with Section 506 of the *Energy Code*, including the modifica-

tions to the Whole Building Analysis (WBA) procedures of the *Energy Code*.

603.3.1 Electrical system efficiency performance path. RESERVED.

603.4 Qualified software for determinations of annual energy use. Calculation software tools and procedures used to comply with Section 603 shall include the capabilities identified in accordance with Section 506 of the *Energy Code*.

603.5 Design professional in responsible charge of building energy simulation. For purposes of this section, and where it is required that documents be prepared by a *building modeling professional as outlined under the Whole Building Approach guidelines*, the *code official* shall be authorized to require the owner to engage and designate on the *building permit* application a *building modeling professional* who shall act as the *building modeling professional in responsible charge of* building *energy simulation*. If the circumstances require, the owner shall designate a substitute *building modeling professional in responsible charge of building energy simulation* who shall perform the duties required of the original *building modeling professional in responsible charge of building energy simulation*. The *code official* shall be notified in writing by the owner if the *building modeling professional in responsible charge of building energy simulation* is changed or is unable to continue to perform the duties.

603.6 Minimum requirements for buildings pursuing performance compliance path. RESERVED.

SECTION 604
ENERGY METERING, MONITORING AND REPORTING

604.1 Purpose. *Buildings* that consume energy shall comply with Section 604. The purpose of this section is to provide requirements that will ensure that *buildings* are constructed or altered in a way that will provide the capability for their energy use, production and reclamation to be measured, monitored and reported. This includes the design of energy distribution systems so as to isolate load types, the installation of or ability to install in the future *meters*, devices and a data acquisition system, and the installation of or the ability to provide for public displays and other appropriate reporting mechanisms.

All forms of energy delivered to the *building* and *building site,* produced on the *building site* or in the building and reclaimed at the *building site* or in the *building* shall be *metered* and all energy load types measured in accordance with this section.

604.1.1 Buildings with tenants. RESERVED.

604.2 Intent. The intent of these requirements is to provide for the ongoing *metering*, measuring, reporting and display of the energy use, energy demand associated with the energy use of the whole *building* and its systems.

604.3 Energy distribution design requirements and load-type isolation. Energy distribution systems within, on or adjacent to and serving a *building* shall be designed such that each primary circuit, panel, feeder, piping system or supply mechanism supplies only one energy use type as defined in Sections 604.3.1 through 604.3.6. The energy use type served by each distribution system shall be clearly designated on the energy distribution system with the use served, and adequate space shall be provided for installation of *metering* equipment or other data collection devices, temporary or permanent, to measure their energy use. The energy distribution system shall be designed to facilitate the collection of data for each of the *building* energy use categories in Section 604.4 and for each of the end use categories listed in Sections 604.3.1 through 604.3.5. Where there are multiple *buildings* on a *building site,* each *building* shall comply separately with the provisions of Section 604.

Exception: *Buildings* designed and constructed such that the total usage of each of the load types described in Sections 604.3.1through 604.3.5 shall be permitted to be measured through the use of installed sub-*meters* or other equivalent methods as *approved*.

604.3.1 HVAC system total energy use. This category shall include all energy used to heat, cool and provide *ventilation* to the *building* including, but not limited to, fans, pumps, boiler energy, chiller energy and hot water.

604.3.2 Lighting system total energy use. This category shall include all interior and exterior lighting used in occupant spaces and common areas.

604.3.3 Energy used for building operations. RESERVED.

604.3.4 Plug loads. This category shall include all energy use by devices, appliances and equipment connected to convenience receptacle outlets.

604.3.5 Process and large miscellaneous/building operation loads. This category shall include the energy used by any end-use activity within the building—such as, but not limited to, data centers, elevators, escalators, swimming pools, manufacturing equipment, laboratory equipment, medical equipment, and commercial kitchens—that exceeds 5 percent of the total connected peak demand for each energy type.

604.3.6 Miscellaneous loads. RESERVED.

604.4 Energy-type metering. *Buildings* shall be provided with the capability to determine energy use and peak demand as provided in this section for each of the energy types specified in Sections 604.4.1 through 604.4.6. Utility *energy meters* shall be permitted to be used to collect whole *building* data, and shall be equipped with a local data port connected to a data acquisition system in accordance with Section 604.5. Each energy use-type metering, except electric, shall be determined at a minimum of 1-hour intervals. Electric power metering shall be capable of determining peak demand to the building at 15-minute intervals.

604.4.1 Gaseous fuels. Gaseous fuels including, but not limited to, natural gas, LP gas, coal gas, hydrogen, landfill gas, digester gas and biogas shall be capable of being *metered* at the *building site* to determine the gross consumption and peak demand of each different gaseous fuel by the *building* and each *building* on a *building site.* The installation of gas *meters* and related piping shall be in accordance with the *Mechanical Code*.

604.4.2 Liquid fuels. Liquid fuels including, but not limited, to fuel oil, petroleum-based diesel, kerosene, gasoline, bio diesel, methanol, ethanol and butane shall be capable of being *metered* at the *building site* to allow a determination of the gross consumption and peak demand of each liquid fuel use by the *building* and each *building* on a *building site*. The installation of *meters* and related piping shall be in accordance with the *Mechanical Code*.

604.4.3 Solid fuels. Solid fuels including, but not limited to coal, charcoal, peat, wood products, grains and municipal waste shall be capable of having their use determined at the *building site* to allow a determination of the gross consumption and peak demand of each solid fuel use by the *building* and each *building* on a *building site.*

604.4.4 Electric power. Electric power shall be capable of being *metered* at the *building site* to allow a determination of the gross consumption and peak demand by the *building* and each *building* on a *building site*. The installation of electric *meters* and related wiring shall be in accordance with the *Electrical Code.*

604.4.5 District heating and cooling. Hot water, steam, chilled water and brine shall be capable of being *metered* at the *building site*, or where produced on the *building site*, to allow a determination of the gross consumption of heating and cooling energy by each *building* on a *building site*. Energy use associated with the production of hot water, steam, chilled water or brine shall be determined based on the fuel used.

604.4.6 Combined heat and power. Equipment and systems with a connected load greater than 125,000 Btu/hr providing combined heat and power (CHP) shall be capable of being metered to allow a determination of the gross consumption of each form of delivered energy to the equipment. The output of CHP shall be metered in accordance with the applicable portions of Section 604 based on the form(s) of output from the CHP.

604.4.7 Renewable and waste energy. Equipment and systems providing energy from renewable or waste energy sources shall be capable of being *metered* to allow a determination of the output of such equipment and systems in accordance with Sections 604.4.7.1 through 604.4.7.5.

604.4.7.1 Solar electric. Equipment and systems providing electric power through conversion of solar energy directly to electric power shall be capable of being *metered* such that the peak electric power (kW) provided to the *building* and its systems or to off-site entities can be determined at 15-minute intervals and the amount of electric power (kWh) provided to the *building* and its systems can be determined at a minimum of hourly intervals.

604.4.7.2 Solar thermal. RESERVED.

604.4.7.3 Waste heat. RESERVED.

604.4.7.4 Wind power systems. Equipment and systems providing electric power through conversion of wind energy directly to electric power shall be capable of being *metered* such that the peak electric power (kW) provided to the *building* and its systems or to off-site entities can be determined at 15-minute intervals and the amount of electric power (kWh) provided to the *building* and its systems can be determined at a minimum of hourly intervals.

604.4.7.5 Other renewable energy electric production systems. RESERVED.

604.5 Energy load-type sub-metering. For *buildings* that are 70,000 square feet in *total building floor area* and larger, all of the energy load types as defined in Section 604.3 shall be *metered* through the use of sub-*meters* or other *approved*, equivalent methods meeting the capability requirements of Section 604.4.

604.5.1 Buildings less than 70,000 square feet. For *buildings* that are less than 70,000 square feet (6503 m^2) in *total building floor area*, the energy distribution system shall be designed and constructed in such a way as to accommodate the future installation of sub-*meters* and other *approved* devices in accordance with Section 604.5. This includes, but is not limited to, providing access to distribution lines and ensuring adequate space for the installation of sub-*meters* and other *approved* devices.

604.6 Minimum energy measurement and verification. *Meters,* sub-*meters,* and other approved devices installed in compliance with Sections 604.4 and 604.5 shall be connected to a data acquisition and management system capable of storing not less than 36 months worth of data collected by all *meters* and other *approved* devices and transferring the data in real time to a display as required in Section 604.7.

604.6.1 Annual emissions. RESERVED.

604.7 Energy display. A readily accessible display or internet website shall be made available to the owner and building tenants. The display shall be capable of providing all of the following:

1. The current energy demand for the whole *building* level measurements, updated for each fuel type at the intervals specified in Section 604.4;
2. The average and peak demands for the previous day and the same day the previous year;
3. The total energy and monthly usage for the previous eighteen (18) months.

SECTION 605
AUTOMATED DEMAND RESPONSE (AUTO-DR) INFRASTRUCTURE

605.1 Establishing an open and interoperable automated demand response (Auto-DR) infrastructure. Buildings that contain HVAC or lighting systems shall comply with this section. A *building energy management and control system (EMCS)* shall be provided and integrated with *building* HVAC systems controls and lighting systems controls to receive an open and interoperable *automated demand response (Auto-DR)* relay or internet signal. *Building* HVAC and lighting systems and specific *building* energy-using components shall incorporate preprogrammed demand response strategies

that are automated with a *demand response automation internet software client.*

Exceptions:

1. Buildings less than 50,000 square feet (4645 m^2).
2. Buildings with a peak energy demand not greater than 0.50 times that of the standard reference design.
3. Buildings that have incorporated on-site renewable energy generation to provide 20 percent or more of the building's energy demand.

605.2 Software clients. *Demand response automation internet software* clients shall be capable of communicating with a *demand response automation server* (DRAS).

605.3 Heating ventilating and air-conditioning (HVAC) systems. The *Auto-DR* strategy for HVAC systems shall be capable of reducing the *building* peak cooling or heating HVAC demand by not less than 10 percent when signaled from the electric utility, regional *independent system operator* (ISO) or regional transmission operator (RTO), through any combination of the strategies and systemic adjustments, including, but not limited to the following:

1. Space temperature setpoint reset;
2. Increasing chilled water supply temperatures or decreasing hot water supply temperatures;
3. Increasing or decreasing supply air temperatures for VAV systems;
4. Limiting capacity of HVAC equipment that has variable or multiple-stage capacity control;
5. Cycling of HVAC equipment or turning off noncritical equipment;
6. Disabling HVAC in unoccupied areas;
7. Limiting the capacity of chilled water, hot water and refrigerant control valves;
8. Limiting the capacity of supply and exhaust fans, without reducing the outdoor air supply below the minimum required by Chapter 4 of the *Mechanical Code*, or the minimum required by ASHRAE 62.1;
9. Limiting the capacity of chilled water or hot water supply pumps;
10. Anticipatory control strategies to pre-cool or pre-heat in anticipation of a peak event.

Exceptions:

1. Hospitals and critical emergency response facilities.
2. Life safety ventilation for hazardous materials storage.
3. Building smoke exhaust systems.
4. Manufacturing process systems.

605.3.1 Rebound avoidance. The *Auto-DR* strategy shall include logic to prevent a rebound peak. When the signal for *Auto-DR* is ended, a gradual return to normal HVAC equipment operations shall be part of the *Auto-DR* strategy, through any combination of the strategies and systemic adjustments, including, but not limited to, the following:

1. If close to the unoccupied period, the *Auto-DR* period shall be extended using a *rebound avoidance, extended Auto-DR control* strategy until the initiation of the unoccupied period.
2. *Rebound avoidance, slow recovery* control strategies, gradually increasing or decreasing space temperature setpoints or a variance in the timing by cooling or heating zone.
3. *Rebound avoidance, slow recovery* control strategies, gradually increasing or decreasing zone supply air temperatures.
4. *Rebound avoidance, slow recovery* control strategies, gradually increasing or decreasing chilled water temperatures or decreasing hot water temperatures.
5. *Rebound avoidance, sequential equipment* recovery strategies, gradually restoring *demand limited* equipment capacity.
6. *Rebound avoidance, sequential equipment recovery* strategies, gradually restoring equipment that was turned off during the *Auto-DR* period.
7. *Rebound avoidance, slow recovery control* strategies, gradually increasing capacity for air moving and pumping systems.
8. *Rebound avoidance, sequential equipment recovery* or *rebound avoidance, slow* recovery control where chilled water or hot water and other capacity control valves are sequentially or gradually allowed to return to normal operation, respectively.

605.4 Lighting. The *Auto-DR* system shall be capable of reducing total connected power of lighting in Group B office spaces by not less than 15 percent.

Exceptions:

1. Buildings or portions associated with lifeline services.
2. Luminaires on emergency circuits.
3. Luminaires located in emergency and life safety areas of a *building*.
4. Lighting in *buildings* that are less than 5,000 square feet (0.4645 m^2) in total area.
5. Luminaires located within a *daylight zone* that are dimmable and connected to *automatic daylight controls.*
6. Signage used for emergency, life safety or traffic control purposes.

SECTION 606
BUILDING ENVELOPE SYSTEMS

606.1 Prescriptive compliance. Where buildings are designed using the prescriptive-based compliance path in accordance with Section 602.2.1, *building thermal envelope* systems shall comply with the provisions of the *Energy Code* Section 502 and the provisions of this section.

606.1.1 Insulation and fenestration criteria. The *building thermal envelope* shall meet the requirements of Tables 606.1.1(1) and 606.1.1(2). Assemblies must meet either the prescriptive *R*-value requirements or the *U*-value for the assembly. A building trade-off is allowed: the sum of *U*-value* Area for each assembly type for the Design Case building must be less than the sum of the *U*-value* Area for the building using the *U*-values from Tables 606.1.1(1) and 606.1.1(2).

606.1.1.1 Permanent shading devices for fenestration. Vertical fenestration within 45 degrees of the nearest west, and south cardinal ordinate shall be shaded by permanent horizontal exterior projections with a *projection factor* greater than or equal to 0.25. Where different windows or glass doors have different *projection factor* values, they shall each be evaluated separately, or an area-weighted *projection factor* value shall be calculated and used for all windows and glass doors. Horizontal projections shall extend laterally beyond the edge of the glazing not less than one-half of the height of the glazing, except at *building* corners.

Exceptions:

1. *Buildings* with a mean roof height exceeding that permitted by Table 1504.8 of the *Building Code* based on the exposure category and basic wind speed at the *building site*.
2. Windows located in a *building* wall that is within 18 inches (50 cm) of the *lot* line.
3. Where equivalent shading of the fenestration is provided by *buildings, structures,* geological formations or permanent exterior projections that are not horizontal, as determined by sun angle studies at the peak solar altitude on the spring equinox, and three hours before and after the peak solar altitude on the spring equinox.
4. Buildings where the window wall ratio is less than 20 percent on the walls within 45 degrees of the nearest west and south cardinal ordinate.
5. Renovations, remodels or additions.

TABLE 606.1.1(1)
BUILDING ENVELOPE REQUIREMENTS–OPAQUE ASSEMBLIES

CLIMATE ZONE 5 AND MARINE 4		
	All other	Group R
Roofs		
Insulation entirely above deck	R-30 ci/U=0.032	R-30 ci/U=0.032
Metal buildings (with R-3.5 thermal blocks[a,b])	R-19 + R11 Ls/U=0.035	R-19 + R11LsU=0.035
Attic and other	R-49/U=0.021	R-49/U=0.021
Walls, above grade		
Mass	R-11.4 ci/U=0.090	R-15.2 ci/U=0.060
Metal Building	R-19 ci (R-15.8 Zone 4 Marine)/U=0.050 (U=0.060 Zone 4C)	R-19 ci (R-15.8 Zone 4 Marine))/U=0.050 (U=0.060 Zone 4C)
Metal Framed	R-13 + R-12.5 ci/U=0.049	R-13 + R-12.5 ci/U=0.049
Wood framed and other	R-13 + R-10 ci/U=0.040	R-13 + R-12.5 ci/U=0.040
Walls, below grade		
Below-grade wall	R-7.5 ci/C=0.119	R-7.5 ci/C=0.119
Floors		
Mass	R-14.6 ci/U=0.057	R-14.6 ci/U=0.057
Joist/framing (steel/wood)	R-38/U=0.027	R-38/U=0.027
Slab on grade floors		
Unheated slabs	R-15 for 24 in below/F=0.528	R-20 for 24 in below/F=0.528
Heated slabs	R-15 for 48 in below/F=0.688	R-20 for 48 in below/F=0.688
Opaque doors		
Swinging	U-0.50	U-0.50
Roll-up or sliding	U-0.50	U-0.50

For SI: 1 inch = 25.4 mm.
Ci = Continuous insulation. NR = No requirement.
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method.
b. Assembly descriptions can be found in OEESC Chapter 5.

TABLE 606.1.1(2)
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE 5 AND MARINE 4	
Vertical fenestration (30% maximum of above-grade wall) U-factor	
Framing materials other than metal with or without metal reinforcement or cladding	
U-factor	0.30
Metal framing with or without thermal break	
Curtain wall/storefront and fixed metal *U*-factor	0.40
Entrance door *U*-factor	0.80
All other *U*-factor[a]	0.46
SHGC—all frame types[b] 0.40	
SHGC: PF < 0.25	0.40
SHGC[b]: 0.25 = PF < 0.5	0.50/0.54
SHGC[b]: PF = 0.5	0.54/0.72
Skylights (3% maximum)	
U-factor	0.60
SHGC	0.40

NR = No requirement.

PF = Projection factor (see Section 502.3.2).

a. All others includes operable windows and nonentrance doors.

b. SHGC reduction allowed for projection factors (PF). First value is for glazing facing all directions other than North. Second value is for glazing facing within 45 degrees of true North.

606.1.2 Air leakage. Air leakage mitigation measures shall be provided in accordance with this section.

606.1.2.1 Sealing of the building envelope. The *building thermal envelope* shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed and weather-stripped and additionally sealed with an air barrier film or *approved* solid.

1. All joints, seams and penetrations.
2. Site-built windows, doors and *skylights*.
3. Openings between window and door assemblies and their respective jambs and framing.
4. Utility penetrations.
5. Dropped ceilings or chases adjacent to the *building thermal envelope.*
6. Knee walls.
7. Walls and ceilings separating unconditioned spaces from conditioned spaces.
8. Behind tubs and showers on exterior walls.
9. Common walls between *dwelling units*.
10. Roof access openings.
11. Spandrel areas and junctions.
12. Electrical and phone boxes on exterior walls except where the air barrier extends behind boxes or air-sealed-type boxes are installed.
13. HVAC register boots that penetrate the *building thermal envelope* except where sealed to subfloor or drywall.
14. Other sources of infiltration.
15. Where lighting fixtures with ventilation holes or other similar objects penetrate the continuous air barrier, provisions shall be made to maintain the integrity of the continuous air barrier.

606.1.2.1.1 Air barrier installation. The air barrier material shall be installed, free from holes and breaks, over all exterior walls. Where joints occur horizontally, the upper layer shall be lapped over the lower layer not less than 2 inches (51 mm). Where joints occur vertically, the layers shall be lapped not less than 6 inches (152 mm). The air barrier material shall be continuous to the top of walls, terminated at penetrations and *building* appendages, and taped in accordance with manufacturer's installation instructions.

606.1.2.2 Testing requirement. The building envelope air tightness shall be considered to be acceptable where the tested air leakage is less than 0.25 cfm/ft^2 (4.57 m^3/hr/m^2) when tested at a pressure of .30 in w.c. (75 Pa). Testing shall occur after rough-in and after installation of penetrations of the *building* envelope, including penetrations for utilities, HVAC, plumbing and electrical equipment and appliances. Testing shall be done by a qualified individual in accordance with ASTM E 779.

Exception: Buildings greater than 20,000 square feet (1858 m^2).

606.1.2.3 Outdoor air intakes and exhaust openings. Stair and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the *building* envelope shall comply with Section 502.4.5 of the *Energy Code*.

606.1.2.4 Fireplaces. Wood-burning masonry *fireplaces* shall be provided with combustion air directly from the outdoors and with a means to tightly close off the chimney flue and combustion air outlets when the *fireplace* is not in use.

606.1.2.5 Vestibules. Vestibules shall comply with Section 502.4.6 of the *Energy Code*. Exception 3 shall not apply to any space less than 3,000 square feet (298 m^2) when the space is an atrium three stories or higher or when door(s) from an elevator or stair shaft(s) serving three stories or more opens into the space.

606.1.3 Minimum *skylight* fenestration area. In *enclosed spaces* greater than 10,000 square feet (900 m^2), directly under a roof with ceiling heights greater than 15 feet (4.6 m), and used for or as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, nonrefrigerated warehouse, retail, distribution/sorting area, transportation or workshop, the total *daylight zone under skylights* shall be a minimum of half the floor area and provide a minimum *skylight* area to *daylight zone under skylights* of 3 percent with a skylight VT of at least 0.40.

Skylights shall have a glazing material or diffuser with a measured haze value greater than 90 percent when tested according to ASTM D 1003. General lighting in the daylight area shall be controlled as described in the *Energy Code* Section 505.2.2.3. The skylight area shall not exceed 5 percent of the gross roof area.

Exceptions:

1. Where the designed *general lighting* power densities are less than 0.5 W/ft^2 (5.4 W/m^2).
2. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 am and 4 pm.
3. Where the daylight area under rooftop monitors is greater than 50 percent of the enclosed space floor area.

SECTION 607
BUILDING MECHANICAL SYSTEMS

607.1 Prescriptive compliance. Where buildings are designed using the prescriptive-based compliance path in accordance with Section 602.2.1, *building* mechanical systems shall meet the provisions of the *Energy Code* for such systems and the provisions of this section.

607.1.1 Increased building efficiency. HVAC equipment shall meet the requirements of Section 607.2. In addition, the building shall be designed in accordance with either Section 607.1.1.1, 607.1.1.2, or 607.1.1.3 efficiency improvement measures.

607.1.1.1 Lighting power density improvement. The total building lighting power density shall be 10 percent less than the lighting power density required under Section 609.1.

607.1.1.2 Building renewable energy system. The total minimum ratings of on-site renewable energy systems shall comply with one of the following:

1. Provide not less than 1.75 Btus, or not less than 0.50 watts, per square foot of conditioned floor area.
2. Provide not less than 3 percent of the energy used within the building for building mechanical and service water heating equipment and lighting regulated by the prescriptive requirements of Chapter 6.

607.1.1.3 Increased mechanical efficiency. Increased efficiency may be met by complying with HVAC equipment efficiency improvements listed in Section 607.2.4.

607.2 HVAC equipment performance requirements. HVAC equipment shall comply with Sections 607.2.1 through 607.2.3.

607.2.1 Equipment covered by federal standards. Equipment covered by federal minimum efficiency standards shall meet the minimum efficiency requirements of the *Energy Code*.

607.2.2 Equipment not covered by federal standards. Equipment not covered by federal minimum efficiency standards shall meet the minimum efficiency requirements of this section.

607.2.2.1 Ground source heat pumps. The efficiency of ground source heat pumps shall meet the provisions of Table 607.2.2.1 based on the applicable referenced test procedure.

607.2.2.2 Multi-stage ground source heat pumps. The efficiency of multi-stage ground source heat pumps shall meet the provisions of Table 607.2.2.1 based on the applicable referenced test procedure.

TABLE 607.2.2.1
ENERGY-EFFICIENCY CRITERIA FOR GROUND SOURCE HEAT PUMPS

PRODUCT TYPE	MINIMUM EER	MINIMUM COP	TEST PROCEDURE
Water-to-air closed loop	14.1	3.3	ISO 13256-1
Water-to-air open loop	16.2	3.6	ISO 13256-1
Water-to-water closed loop	15.1	3.0	ISO 13256-2
Water-to-water open loop	19.1	3.4	ISO 13256-2
Direct expansion (DX) or direct geoexchange (DGX)	15.0	3.5	AHRI 870

607.2.2.3 Ventilating fans. RESERVED.

607.2.3 HVAC system controls. RESERVED.

607.2.3.1 Programmable thermostats. RESERVED.

607.2.4 HVAC equipment performance improvement. When Section 607.1.1.3 is followed, HVAC equipment shall meet or exceed the requirements of the following tables. Where equipment is not listed, the equipment shall exceed the latest federal efficiency standards by 10 percent.

607.3 Ventilation (Reference also OEESC 503.2.5). *Ventilation*, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *Mechanical Code.* Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *Mechanical Code*, or the minimum required by Section 6.3 of ASHRAE 62.1.

607.3.1 Excess ventilation. Ventilation rates shall not be designed to exceed the minimum requirements of the *Mechanical Code* or ASHRAE 62.1. Where the design ventilation exceeds the minimum, the system shall have an energy recovery ventilation system meeting the performance requirements of Section 503.2.6 of the *Energy Code*.

607.4 Duct and plenum insulation, sealing and testing. (Reference also OEESC 503.2.7) Supply and return air ducts and plenums, and air handlers and filter boxes shall be insulated and sealed in accordance with the *Energy Code* except as noted herein.

TABLE 607.2.4(1)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]
Air conditioners Air cooled	< 65,000 Btu/h	Split system	For Zones 1 to 5: 15.0 SEER, 12.5 EER
		Single package	For Zones 1 to 5: 15.0 SEER, 12.0 EER
	≥ 65,000 Btuh/h and < 240,000 Btu/h	Split system and single package	For Zones 1 to 5: 12.0 EER[b], 12.54 IEER[b]
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	For Zones 1 to 5: 10.8 EER[b], 11.3 IEER[b]
	≥ 760,000 Btu/h		For Zones 1 to 5: 10.2 EER[b], 10.7 IEER[b]
Air conditioners, Water and evaporatively cooled		Split system and single package	14.0 EER

For SI: 1 British thermal unit per hour = 0.2931 W.
a. IEERs are only applicable to equipment with capacity modulation. Zones refer to climate zones in the *Energy Code*, Section 303.1.
b. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

TABLE 607.2.4(2)
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED, EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]
Air cooled (cooling mode)	< 65,000 Btu/h	Split system	For Zones 1 to 5: 15.0 SEER, 12.5 EER
		Single package	For Zones 1 to 5: 15.0 SEER, 12.0 EER
	≥ 65,000 Btu/h and < 240,000 Btu/h	Split system and single package	For Zones 1 to 5: 12.0 SEER, 12.4 EER
	≥ 240,000 Btu/h	Split system and single package	For Zones 1 to 5: 12.0 SEER, 12.4 EER
Water sources (cooling mode)	< 135,000 Btu/h	85°F entering water	14.0 EER
Air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)	Split system	For Zones 1 to 5: 9.0 HSPF
		Single package	For Zones 1 to 5: 8.5 HSPF
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	3.4 COP
		17°F db/15°F wb outdoor air	2.4 COP
	≥ 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air	3.2 COP
		77°F db/15°F wb outdoor air	2.1 COP
Water sources (heating mode)	< 135,000 Btu/h (cooling capacity)	70°F entering water	4.6 COP

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.2931 W.
db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F
a. IEERs and Part load rating conditions are only applicable to equipment with capacity modulation. Zones refer to climate zones in the *Energy Code*, Section 301.1.

TABLE 607.2.4(3)
PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY
Air conditioners & Heat pumps (cooling mode)	< 7,000 Btu/h	11.9 EER
	7,000 Btu/h and < 10,000 Btu/h	11.3 EER
	10,000 Btu/h and < 13,000 Btu/h	10.7 EER
	> 13,000 Btu/h	9.5 EER

TABLE 607.2.4(4)
WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, WARM AIR DUCT FURNACES AND UNIT HEATERS, EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
Warm air furnaces, gas fired[a]	< 225,000 Btu/h	—	For Zones 3 and 4 90 AFUE or 90 *Et*[c] For Zone 8 92 AFUE or 92 *Et*[c]	DOE 10 CFR Part 430 or ANSI Z21.47
	≥ 225,000 Btu/h	Maximum capacity	90% *Ec*[b]	ANSI Z21.47
Warm air furnaces, oil fired[a]	< 225,000 Btu/h	—	For Zones 3 to 8 85 AFUE or 85 *Et*[c]	DOE 10 CFR Part 430 or UL 727
	≥ 225,000 Btu/h	Maximum capacity	85% E_t[b]	UL 727
Warm air duct furnaces, gas fired[a]	All capacities	Maximum capacity	90% E_c	ANSI Z83.8
Warm air unit heaters, gas fired	All capacities	Maximum capacity	90% E_c	ANSI Z83.8
Warm air unit heaters, oil fired	All capacities	Maximum capacity	90% E_c	UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

E_t = Thermal efficiency.

E_c = Combustion efficiency (100% less flue losses).

a. Efficient furnace fan: Fossil fuel furnaces in Zones 3 to 8 shall have a furnace electricity ratio not greater than 2 percent and shall include a manufacturer's designation of the furnace electricity ratio.

b. Units must also include an IID (intermittent ignition device), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

c. Where there are two ratings for units not covered by the National Appliance Energy Conservation Act of 1987 (NAECA) (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]), units shall be permitted to comply with either rating.

TABLE 607.2.4(5)
BOILER, EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	FUEL	SIZE CATEGORY	TEST PROCEDURE	MINIMUM EFFICIENCY
Steam	Gas	< 300,000 Btu/h	DOE 10 CFR Part 430	83% AFUE
		> 300,000 Btu/h and > 2.5 mBtu/h	DOE 10 CFR Part 431	81% E_t
		> 2.5 mBtu/h		82% E_c
	Oil	< 300,000 Btu/h	DOE 10 CFR Part 430	85% AFUE
		> 300,000 Btu/h and > 2.5 mBtu/h	DOE 10 CFR Part 431	83% E_t
		> 2.5 mBtu/h		84% E_c
Hot water	Gas	< 300,000 Btu/h	DOE 10 CFR Part 430	97% AFUE
		> 300,000 Btu/h and > 2.5 mBtu/h	DOE 10 CFR Part 431	97% E_t
		> 2.5 mBtu/h		94% E_c
	Oil	< 300,000 Btu/h	DOE 10 CFR Part 430	90% AFUE
		> 300,000 Btu/h and > 2.5 mBtu/h	DOE 10 CFR Part 431	88% E_t
		> 2.5 mBtu/h		87% E_c

E_t = Thermal efficiency.

E_c = Combustion efficiency (100 percent less flue losses).

TABLE 607.2.4(6)
CHILLERS—EFFICIENCY REQUIREMENTS[a,b]

EQUIPMENT TYPE	SIZE CATEGORY	REQUIRED EFFICIENCY—CHILLERS	OPTIONAL COMPLIANCE PATH—MINIMUM EFFICIENCY—CHILLERS WITH VSD		
		Full Load (KW /TON)	IPLV(KW /TON)	Full Load (KW /TON)	IPLV(KW /TON)
Air cooled with condenser	All	1.2	1.0	N/A	N/A
Air cooled without condenser	All	1.08	1.08	N/A	N/A
Water cooled, reciprocating	All	0.840	0.630	N/A	N/A
Water cooled, rotary screw and scroll	< 90 tons	0.780	0.600	N/A	N/A
	90 tons and < 150 tons	0.730	0.550	N/A	N/A
	150 tons and < 300 tons	0.610	0.510	N/A	N/A
	> 300 tons	0.600	0.490	N/A	N/A
Water cooled, centrifugal	< 150 tons	0.610	0.620	0.630	0.400
	150 tons and < 300 tons	0.590	0.560	0.600	0.400
	300 tons and < 600 tons	0.570	0.510	0.580	0.400
	> 600 tons	0.550	0.510	0.550	0.400

a. Compliance with both full-load efficiency numbers and IPLV numbers is required.
b. Only chillers with variable speed drives (VSD) may use the optional compliance path for chiller efficiency.
N/A – No credit can be taken for this option.

TABLE 607.2.4(7)
ABSORPTION CHILLERS—EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	MINIMUM EFFICIENCY FULL LOAD COP (IPLV)
Air cooled, single effect	0.60, allowed only in heat recovery applications
Water cooled, single effect	0.70, allowed only in heat recovery applications
Double effect - direct fired	1.0 (1.05)
Double effect - indirect fired	1.20

607.4.1 Duct Air Leakage Testing (Reference also OEESC 503.2.7.1.3). Ductwork that is designed to operate at static pressures exceeding 3 inches water column and all ductwork located outdoors shall be leak tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual.* Representative sections totaling not less than 25 percent of the total installed duct area for the designated pressure class shall be tested. Positive pressure testing is acceptable for negative pressure ductwork. Duct systems with pressure ratings in excess of 3 inches water column shall be identified on the construction documents. The maximum permitted duct leakage shall be in accordance with Equation 6-7.

$$F = C_L P^{0.65} \quad \textbf{(Equation 6-7)}$$

Where:

F = maximum permitted leakage in cfm/100 ft^2 duct surface area;

C_L = 4, duct leakage class, cfm/100 ft^2 at 1-inch water column.

P = test pressure, which shall be equal to the design duct pressure class rating inches of water column.

607.5 HVAC piping insulation (Reference also OEESC 503.2.8). Piping, including valves, fittings and piping system components, in HVAC systems shall be thermally insulated in accordance with Table 607.5. *Building* cavities and interstitial framing spaces shall be large enough to accommodate the combined diameter of the pipe plus the insulation, plus the full thickness of the insulation plus any other objects in the cavity that the piping must cross.

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with Section 607.2.
2. Piping conveying fluids having a design operating temperature range between 60°F (16°C) and 105°F (40°C).
3. Piping conveying fluids not heated or cooled such as roof and condensate drains, cold water supply, and natural gas piping.

4. Where heat gain or heat loss will not increase energy usage such as liquid refrigerant piping.
5. Piping having an outside diameter of 1 inch (25 mm) or less, associated with strainers, control valves and balancing valves.

TABLE 607.5
MINIMUM PIPE INSULATION THICKNESS[a]

FLUID	CONDUCTIVITY Btu-in./(h-ft^2-F)	WALL THICKNESS[d] OF PIPE INSULATION RELATIVE TO NOMINAL PIPE DIAMETER[b, c]
Steam	0.27 – 0.34	At least double
Hot water	0.22 – 0.29	At least the same
Chilled water	0.22 – 0.28	At least the same

a. Piping with a nominal diameter larger than $^1/_4$ inch shall be insulated.
b. The proportions in this column apply to all nominal pipe diameters greater than $^1/_4$ inch and less than or equal to 2 inches. For nominal pipe diameters larger than 2 inches, outside diameter, the minimum wall thickness of the insulation shall be equal to the wall thickness required for 2 inch pipe.
c. For insulation outside the stated conductivity range, the minimum thickness shall be determined as follows: $T = r[(1 + t/r)K/k - 1]$.
Where:
T = minimum insulation thickness (inches).
r = actual outside radius of pipe (inches).
t = insulation thickness listed in the table for applicable fluid temperature and pipe size.
K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu · in./h · ft^2 · °F).
k = the upper value of the conductivity range listed in the table for the applicable fluid temperature.
d. These thicknesses are based on energy efficiency considerations only.

607.6 Economizers (Reference also OEESC 503.3.1 and 503.4). Economizers shall meet the requirements of the *Energy Code*, except as noted herein.

607.6.1 Air Economizer systems (Reference also OEESC 503.3.1 and 503.4.1). Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Section 607.6.1.1 or 607.6.1.2, respectively.

Exception: Per *Energy Code* Sections 503.3.1 and 503.4.1.

607.6.1.1 Air economizers. Air economizers shall be designed in accordance with Sections 607.6.1.1.1 through 607.6.1.1.4.

607.6.1.1.1 Design capacity. Air economizer systems shall be capable of modulating *outdoor air* and return air dampers to provide up to 100 percent of the design supply air quantity as *outdoor air* for cooling.

607.6.1.1.2 Control signal. Economizer dampers shall be capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed air temperature.

Exception: The use of mixed air temperature limit control shall be permitted for systems controlled from space temperature, such as single-zone systems.

607.6.1.1.3 High-limit shutoff. Air economizers shall be capable of automatically reducing *outdoor air* intake to the design minimum *outdoor air* quantity when the *outdoor air* intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table 607.6.1.1.3(1). High-limit shutoff control settings for these control types shall be those listed in Table 607.6.1.1.3(2).

607.6.1.1.4 Relief of excess outdoor air. Systems shall provide a means to relieve excess *outdoor air* during air economizer operation to prevent over-pressurizing of the *building*. The relief air outlet shall be located to avoid recirculation into the *building*.

TABLE 607.6.1.1.3(1)
HIGH-LIMIT SHUTOFF CONTROL OPTIONS FOR AIR ECONOMIZERS

CLIMATE ZONES	ALLOWED CONTROL TYPES	PROHIBITED CONTROL TYPES
4c 5b	Fixed dry bulb Differential dry bulb Electronic enthalpy[a] Differential enthalpy Dew-point and dry-bulb temperatures	Fixed enthalpy

a. Electronic enthalpy controllers are devices that use a combination of humidity and dry-bulb temperature in their switching algorithm.

TABLE 607.6.1.1.3(2)
HIGH-LIMIT SHUTOFF CONTROL SETTING FOR AIR ECONOMIZERS

DEVICE TYPE	CLIMATE	REQUIRED HIGH LIMIT (ECONOMIZER OFF WHEN)	
		EQUATION	DESCRIPTION
Fixed dry bulb	4c, 5b	$T_{OA} > 75°F$	Outdoor air temperature exceeds 75°F
Differential dry bulb	4c, 5a	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Electronic enthalpy	All	(T_{OA}, RH_{OA}) > A	Outdoor air temperature/ RH exceeds the "A" setpoint curve[a]
Differential enthalpy	All	$h_{OA} > h_{RA}$	Outdoor air enthalpy exceeds return air enthalpy
Dew-point and dry bulb temperatures	All	$DP_{OA} > 55°F$ or $T_{OA} > 75°F$	Outdoor air dry bulb exceeds 75°F or outside dew point exceeds 55°F (65 gr/lb)

a. Setpoint "A" corresponds to a curve on the psychometric chart that goes through a point at approximately 75°F and 40 percent relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

607.6.2 Water Economizer systems for HVAC Equipment (Reference also OEESC 503.4). Economizer systems for HVAC equipment shall be designed in accordance with Sections 607.6.2.2 through 607.6.2.4.

607.6.2.1 Design capacity. RESERVED.

607.6.2.2 Maximum pressure drop. Pre-cooling coils and water-to-water heat exchangers used as part of a water economizer system shall have a water-side pressure drop of less than 15 feet (4572 mm) of water column, including the control valve, or a secondary loop

shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling noneconomizer mode.

607.6.2.3 Integrated economizer control. (Reference also OEESC 503.4.1). Economizer systems shall be integrated with the mechanical cooling system and shall be capable of providing partial cooling whether or not additional mechanical cooling is required to meet the remainder of the cooling load.

607.6.2.4 Economizer heating system impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

Exception: Economizers on VAV systems that cause zone level heating to increase because of reduction in supply air temperature.

607.7 Variable air volume (VAV) systems. (Reference also OEESC 503.4.2). VAV systems shall comply with Sections 607.7.1 through 607.7.3.

607.7.1 VAV fan control. Individual fans with motors equal to or greater than 1.0 horsepower (0.746 kW) shall be one of the following:

1. Driven by a mechanical or electrical variable speed drive.
2. Driven by a vane-axial fan with variable-pitch blades
3. Provided with controls or devices that will result in fan motor demand of not more than 30 percent of its design wattage at 50 percent of design airflow when static pressure set point equals one-third of the total design static pressure, based on manufacturer's certified fan data.

The static pressure set point shall be reset at the central control panel, based on the *zone* requiring the most pressure. The set point shall be reset lower until one *zone* damper is wide open.

Exception: Systems without zone dampers are exempt from the static pressure reset requirements.

607.7.2 VAV Reheat. Reheating of VAV primary air is prohibited. Space heating shall be furnished separately from the VAV system.

Exception: Only the minimum ventilation air required by Chapter 4 of the *Mechanical Code* or other code may be reheated.

607.7.3 VAV system ventilation optimization. Individual zone boxes of a multiple-zone VAV system shall report to a central control panel that automatically reduces outdoor air intake flow below design rates in response to changes in *system ventilation efficiency* as defined by ASHRAE Standard 62.1, Appendix A.

Exceptions:

1. Dual VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
2. Systems required to have exhaust air energy recovery complying with OEESC Section 503.2.6.

607.8 Kitchen exhaust systems (Reference also OEESC 503.2.5.2). Kitchen exhaust systems shall meet the provisions of the *Energy Code* except as noted herein.

607.8.1 Kitchen exhaust systems. Replacement air introduced directly into the exhaust hood cavity shall not exceed 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space containing a kitchen hood shall not exceed the greater of the *ventilation* rate required to meet the space heating or cooling load or the hood exhaust flow minus the available transfer air from adjacent spaces where available transfer air is considered to be that portion of outdoor *ventilation* air not required to satisfy other exhaust needs, such as restrooms, and not required to maintain pressurization of adjacent spaces.

Where the total kitchen hood exhaust airflow rate is greater than 5,000 cfm (2360 L/s), each hood shall be UL 710 listed and have a maximum exhaust rate in accordance with Table 607.8.1.

Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

Exception: Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.

607.9 Laboratory exhaust systems. Laboratory exhaust systems shall meet the provisions of the *Energy Code* except as noted herein.

607.9.1 Laboratory exhaust systems. RESERVED.

TABLE 607.8.1
MAXIMUM NET EXHAUST FLOW RATE (CFM PER LINEAR FOOT)

TYPE OF HOOD	LIGHT DUTY EQUIPMENT	MEDIUM DUTY EQUIPMENT	HEAVY DUTY EQUIPMENT	EXTRA HEAVY DUTY EQUIPMENT
Wall-mounted canopy	140	210	280	385
Single island	280	350	420	490
Double island (per side)	175	210	280	385
Eyebrow	175	175	Not allowed	Not allowed
Backshelf/Passover	210	210	280	Not allowed

For SI: 1 CFM/linear foot (1.55 L/s per meter).

607.10 Control of HVAC in hotel/motel guest rooms. A dedicated system to automatically control HVAC system energy shall be installed to control guest room HVAC energy consumption during unoccupied periods. Such controls shall be designed to raise cooling and lower heating temperature set points by at least 4ºF (2ºC) during unoccupied periods.

Exception: Group R-1, Hotels and Motels, with fewer than 20 guest rooms.

SECTION 608
BUILDING SERVICE WATER HEATING SYSTEMS

608.1 Prescriptive compliance. Where buildings are designed using the prescriptive-based compliance path in accordance with Section 602.2.1, service water heating systems shall meet the provisions of the *Energy Code* for such systems and the provisions of this section.

608.2 Service water heating (SWH) equipment performance requirements. (Reference also OEESC 504.2). Service water heating equipment shall comply with Sections 608.2.1.

608.2.1 Equipment covered by Federal standards. Equipment covered by federal minimum efficiency standards shall meet the minimum efficiency requirements of the *Energy Code*.

608.2.2.1 Water heater controls for dwelling units. RESERVED.

608.2.2.2 Pools, hot tubs and spas. (Reference also OEESC 504.7). Pools, hot tubs and spas shall meet the efficiency requirements of the *Energy Code.*

608.3.1 Pools in conditioned space. RESERVED.

608.4 Snow melt systems. Snow melt systems shall comply with the requirements of the *Energy Code*.

608.5 Rough-ins for future solar hot water pre-heat. Plumbing, electrical and control systems shall be designed and constructed in accordance with Sections 608.5.1 and 608.5.2 to provide for the future installation of a solar water heating system that will be capable of providing not less than 50 percent of the energy needed for all systems listed below:

1. Service water heating for kitchen, laundry and bathing.
2. Pool water heating.
3. Spa water heating.
4. Hot tub water heating.

Exception: Solar water heating equipment is not required at building sites where solar insulation totals not more than 3.5 (kWh/m²/day) or if other renewable option is selected as a project elective indicated on the checklist required under Section 303.

608.5.1 Solar thermal hot water system piping rough-in. Conduit, sleeve or other pathway shall be installed not less than two runs of piping from the future site for *solar thermal* to the location of the service water heating equipment. The conduit(s), sleeve(s) or other pathway(s) shall have internal dimensions large enough to allow the piping and insulation to be easily installed, removed and replaced. The minimum diameter of the piping shall be $^3/_4$ inch (19.1 mm) nominal and the tubing shall be certified to handle sustained temperatures above 180°F (82°C). Insulation shall be sized in accordance with Section 607.5.

608.5.2 Solar thermal hot water system electrical rough-in. Conduit not less than $^3/_4$ inch (19.1 mm) in size shall be installed from the electric service panel or room that provides the electric service to the water heating equipment room that will be served by the solar hot water system.

608.5.2.1 Control conduit size. Conduit not less than $^3/_4$ inch (19.1 mm) in size shall be installed from the future *solar thermal* or solar electric site to the location of the service water heating equipment and the *storage tank* to provide for control wiring.

608.5.2.2 Terminations. Conduits, sleeves and pathways installed in accordance with this section shall terminate near the *solar thermal* or solar electric sites and shall be readily accessible.

608.5.2.3 Space for future storage tank. Space for a future storage tank shall be identified and reserved. This space shall be large enough to accommodate storage for a *solar thermal* system sized to provide 50-percent solar fraction, with an area of not less than 10 square feet (0.93 m²).

608.6 Waste water energy recovery system. The following *building* types shall be provided with a waste water heat recovery system that will preheat all of the incoming water used for all hot water functions by not less than 10ºF (5.6ºC):

1. Group F, Laundries.

608.7 Service water heating piping insulation (Reference also OEESC 504.5). Where service water heating insulation is required by the *Energy Code,* service water heating piping shall be thermally insulated in accordance with Table 607.5. Where hot water *distribution piping* is installed within attics and crawlspaces, the insulation shall continue to cover the pipe for a distance of at least 6 inches (152 mm) beyond the *building thermal envelope.* Where hot water *distribution piping* is installed within walls, the insulation must completely surround the pipe with not less than 1 inch (25 mm) of insulation. Hot water piping runouts installed within exterior walls insufficient to accommodate the pipe and insulation levels of Table 607.5 shall be permitted to have the maximum thickness that the wall can accommodate, but not less than $^1/_2$-inch (12.7 mm) thick.

Exceptions:

1. Factory-installed piping within service water heating equipment tested and rated in accordance with Section 607.5.
2. Piping conveying fluids not heated or cooled such as cold water supply, and natural gas piping.
3. Hot water supply piping exposed under sinks, lavatories and similar fixtures.
4. Hot water *distribution piping* buried within blown-in or sprayed roof/ceiling insulation, such as fiberglass or cellulose, where the insulation completely and continuously surrounds the pipe.

608.7.1 Buried piping. Service hot water piping installed within a slab or below grade shall be insulated in accordance with Section 608.7 and shall be placed within a physically protective, waterproof channel or sleeve having internal dimensions large enough such that the piping and insulation can be removed and replaced, and maintain its dimensional integrity during and after construction.

Exception: Where the insulation manufacturer stipulates that the pipe insulation will maintain its insulating value in underground applications in damp soil where installed according to the manufacturer's instructions. This exception does not apply to piping that runs under *building* slabs.

608.8 Circulating hot water systems (Reference also OEESC 504.6). Circulating hot water systems shall be provided with an *automatic* or readily accessible *manual* switch to turn off the hot water circulating pump when not in use. Controls that allow continuous, timer or water temperature-initiated operation of a circulating pump are prohibited. Gravity or thermosyphon circulation loops are prohibited. Pumps on circulating hot water systems shall be activated on demand by either a hard-wired or wireless activation control of one of the following types:

1. A normally-open, momentary contact switch.
2. Motion sensors that make momentary contact when motion is sensed. After the signal is sent, the sensor shall go into a lock-out mode for not less than 5 minutes to prevent sending a signal to the electronic controls while the circulation loop is still hot.
3. A flow switch.
4. A door switch.

The controls for the pump shall be electronic and operate on the principal of shutting off the pump with a rise in temperature. Electronic controls shall have a lock-out to prevent operation exceeding 105ºF (40°C) in the event of failure of the device that senses temperature rise. The electronic controls shall have a lock out mode for not more than 5 minutes that prevents extended operation of the pump if the sensor fails or is damaged.

SECTION 609
BUILDING ELECTRICAL POWER AND LIGHTING SYSTEMS

609.1 General. Where buildings are designed using the prescriptive-based compliance path in accordance with Section 602.3.1, building electrical power and lighting systems shall meet the provisions of the *Energy Code* for such systems and the provisions of Section 609.

609.1.1 Lighting power density (LPD) table. Calculation of interior LPD allowance shall be per Tables 609.1.1(a) and 609.1.1(b), superseding OEESC tables 505.2(a) and 505.2(b).

TABLE 609.1.1(a)
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type	(W/ft^2)
Automotive facility	0.79
Convention center	1.08
Court house	1.05
Dining: bar lounge/leisure	0.99
Dining: cafeteria/fast food	0.90
Dining: family	0.89
Dormitory	0.61
Exercise center	0.88
Gymnasium	1.00
Health care—clinic	0.87
Hospital	1.08
Hotel	0.88
Library	1.17
Manufacturing facility	1.24
Motel	0.88
Motion picture theater	0.83
Multifamily	0.58
Museum	1.04
Office	0.90
Parking garage	0.26
Penitentiary	1.00
Performing arts theater	1.39
Police/fire station	0.89
Fire station	0.74
Post office	0.87
Religious building	1.05
Retail	1.32
School/university	0.99
Sports arena	0.78
Town hall	0.92
Transportation	0.77
Warehouse	0.66
Workshop	1.20

For SI: 1 foot = 304.8 mm, 1 watt per square foot = $W/0.0929\ m^2$.

609.2 Sleeping unit controls (Reference also OEESC 505.2.3). *Sleeping units* in hotels, motels, boarding houses or similar *buildings* shall have a control system for detecting occupancy to shut off all permanently wired luminaires and switched receptacles, except those in bathrooms, when the unit is not occupied.

Exception: Sleeping unit controls are not required in *sleeping units* where all lighting and switched receptacles are controlled by an *occupant sensor* that requires *manual* intervention to energize circuits.

TABLE 609.1.1(b)
SPACE-BY-SPACE METHOD MAXIMUM ALLOWABLE LIGHTING POWER DENSITY (LPD)

Common Space Types	LPD (W/ft^2)[a]
Office—enclosed[b]	0.97
Office—open plan[b]	0.93
Conference/meeting/multipurpose[c]	1.11
Classroom/lecture/training	1.23
Lobby	1.28
For hotel	1.1
For performing arts theater	3.24
For motion picture theater	1.01
Audience/seating area	0.84
For gymnasium	0.4
For exercise center	0.27
For convention center	0.7
For religious buildings	1.60
For sports complex	0.4
For performing arts theater	2.52
For motion picture theater	1.11
For transportation	0.46
Atrium—first three floors	0.6
Atrium—each additional floor	0.16
Lounge/recreation	1.16
For hospital	0.71
Dining area[b]	
For hotel/motel	1.23
For bar lounge/leisure dining	1.4
For family dining	2.1
Food preparation	1.07
Laboratory	1.4
Restrooms	0.82
Dressing/locker room	0.52
Corridor/transition	0.41
For hospital	0.94
For manufacturing facility	0.41
Stairs—active	0.49
Active storage	0.66
For hospitals	0.79
Inactive storage	0.26
For museum	0.66
Electrical/mechanical	1.24
Workshop[d]	1.64
Building Specific Space Types	**LPD (W/ft^2)**
Courthouse/police station	
Courtroom	1.78
Judge chambers	1.18
Gymnasium/exercise center	
Playing area	1.35
Exercise area	

continued

TABLE 609.1.1(b)—continued
SPACE-BY-SPACE METHOD MAXIMUM ALLOWABLE LIGHTING POWER DENSITY (LPD)

Fire stations	
Fire station engine room	0.64
Sleeping quarters	0.27
Post office—sorting area	1.01
Convention center—exhibit space[c]	1.09
Library[b]	
Card file and cataloging	0.96
Stacks	1.47
Reading area	1.07
Hospital	
Emergency	2.34
Recovery	0.74
Nurse station	0.85
Exam/treatment room	1.26
Pharmacy	0.99
Patient room	0.59
Operating room	1.92
Nursery	0.48
Medical supply	1.23
Physical therapy	0.80
Radiology	0.35
Laundry—washing	0.52
Automotive—service/repair	0.63
Museum	
General exhibition	1.0
Restoration	1.58
Bank/office—banking activity area	1.31
Religious buildings	
Worship—pulpit, choir	2.29
Fellowship hall	0.81
Retail	1.5
Mall concourse	1.5
Fitting room	1.06
Sports arena complex	
Ring sports area	2.70
Court sports area	2.00
Indoor playing field area	1.35
Warehouse	
Fine material storage	1.24
Medium/bulky material storage	0.81
Parking garage—garage area	0.2
Transportation	
Airport—concourse	0.57
Air/Train/Bus—baggage area	0.89
Terminal—ticket counter	1.31

For SI: 1 foot = 304.8 mm, 1 square foot = 0.929 m^2, W/m^2 = W/ft^2 × 10.764

a. The watts per square foot may be increased by 2 percent per foot of ceiling height above 20 feet unless specified differently by another footnote.

b. The watts per square foot of room may be increased by 2 percent per foot of ceiling height above 9 feet.

c . Hotel banquet room, conference rooms, or exhibit hall watt per square foot of room may be increased by 2 percent per foot of ceiling height above 12 feet.

d. Spaces used specifically for manufacturing are exempt.

609.2.1 Sleeping unit bathroom controls. All permanently wired luminaires located in bathrooms within *sleeping units* in hotels, motels, boarding houses or similar *buildings* shall be equipped with *occupant sensors* that require manual intervention to energize circuits.

Exception: Up to 5 watts of lighting in each bathroom shall be permitted to be connected to the *captive key control* at the main room entry instead of being connected to the *occupant sensor control.*

609.3 Interior light reduction controls (Reference also OEESC 505.2.2.1). *Occupant sensor controls* shall be provided to automatically reduce connected lighting power by not less than 45 percent during periods when occupants are not present in the following location:

1. Storage and stack areas not open to the public.

Lighting in means of egress shall comply with the luminance or uniformity criteria required by the *Building Code.*

Exception: Automatic power reduction shall not be required where *occupant sensor controls* are overridden by *time switch controls* that keep lights on continuously during peak occupancy periods.

609.4 Exterior lighting controls (Reference also OEESC 505.2.4). Exterior lighting shall comply with the requirements of Sections 609.4.1 and 609.4.2.

609.4.1 Exterior light reduction. Exterior lighting shall be controlled by a *time switch* and configured so that the total exterior lighting power is automatically reduced by not less than 30 percent within two hours after *facility operations* conclude.

Exception: Exterior lighting controls need not be controlled for the following occupancies and conditions:

1. Group H occupancies.
2. Group I-3 occupancies.
3. Lighting which is connected to *occupant sensor controls.*
4. Lighting within means of egress.
5. Solar powered luminaires that are not connected to a centralized power source.

609.4.2 Exterior lighting and signage shutoff. The lighting of *building* facades, signage and landscape features shall be controlled by a time switch and configured so that it automatically shuts off within one hour after *facility operations* conclude or as established by the *jurisdiction*. Where *facility operations* are continuous, decorative lighting of *building* facades and landscape features shall automatically shut off at midnight. Lighting shall be turned on no earlier than 6:00 am or within 30 minutes of the start of facility operations, whichever is later.

609.5 Automatic daylight controls (Reference also OEESC 505.2.2.3). *Automatic daylight controls* shall be provided in all *daylight zones* with minimum *fenestration* as specified in Section 505.2.2.3 of the *Energy Code* and Section 808 of this code.

Exceptions: In addition to exceptions listed in *Energy Code* Section 505.2.2.3, automatic daylight controls are not required for the following spaces and equipment:

1. *Toplight daylight zones* where the skylight is located in an *obstructed roof.*
2. *Sidelight daylight zones* where the vertical *fenestration* is located in an *obstructed exterior wall.*
3. Spaces with less than 90 watts of lighting installed in the *daylight* zone.
4. Spaces where medical care is directly provided.
5. Spaces within *dwelling units* or *sleeping units.*

609.6 Plug load controls. At least 50 percent of all 125-volt 15- and 20-ampere receptacles installed in the following space types:

1. Private offices.
2. Computer classrooms.

Shall be controlled by an automatic control device that shall function on:

a. A scheduled basis using a time-of-day operated control device that turns receptacles off at specific programmed times. An independent program schedule shall be provided for areas of no more than 25,000 square feet (2322.5 m^2) but not more than one floor; or

b. An occupant sensor that turns off receptacles within 30 minutes of all occupants leaving a space; or

c. A signal from another control or alarm system that indicates the area is unoccupied.

Exception: Receptacles for the following shall not require an automatic control device:

a. Receptacles specifically designated for equipment requiring 24-hour operation.

b. Spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s).

c. Receptacles equipped with a portable occupancy sensor or time clock device, for example, power strips with an occupancy sensor.

609.6.1 Distribution and marking. Controlled receptacles and electrical outlets shall be distributed in a reasonably uniform pattern throughout each space. Controlled receptacles shall be marked to differentiate them from uncontrolled receptacles.

609.6.2 Furniture systems. RESERVED.

609.6.3 Computer office equipment. RESERVED.

609.6.4 Audio and visual systems. RESERVED.

609.6.5 Water dispensers. RESERVED.

609.6.6 Refrigerator and freezer cases. RESERVED.

609.7 Fuel gas lighting systems. Fixtures that generate illumination by combustion of fuel gas shall be included in lighting power calculations required under Sections 505.5 and 505.6 of the *Energy Code* by converting the maximum rated *btu*/hr of the luminaire into watts using Equation 6-10.

Wattage Equivalent = Maximum btu/hr rating of the fuel gas lighting system/3.413 **(Equation 6-10)**

Exception: *Historic buildings* in accordance with Section 101.4.5 of the *Energy Code*.

609.7.1 Continuously burning pilot lights. Fixtures that generate illumination by combustion of fuel gas shall not contain continuously burning pilot lights.

609.8 Electrical system efficiency (Reference also OEESC 507.1). Electrical systems shall comply with Section 609.8.1.

609.8.1 Prescriptive compliance. Prescriptive compliance for electrical systems shall be in accordance with Sections 609.8.1.1 through 609.8.1.3.

609.8.1.1 Transformer efficiency. Distribution transformers installed on the load side of the service disconnecting means shall comply with the provisions of Tables 609.8.1.1(1), 609.8.1.1(2) and 609.8.1.1(3), and the Energy Policy Act of 2005, as applicable.

Exceptions:

1. Transformers not covered by the Energy Policy Act of 2005.
2. Transformers for special purpose applications, and not used in general purpose applications.
3. Transformers with multiple voltage taps where the highest tap is not less than 20 percent more than the lowest tap.
4. Drive transformers, rectifier transformers, auto-transformers, uninterruptible power supply transformers, impedance transformers, regulating transformers, sealed and non-ventilating transformers, machine tool transformers, welding transformers, grounding transformers and testing transformers.

609.8.1.2 Voltage drop in feeders. RESERVED.

609.8.1.3 Voltage drop in branch circuits. RESERVED.

609.9 Exterior lighting. (Reference also OEESC 505.6). All exterior lighting shall comply with Section 505.6 of the *Energy Code.*

609.10 Verification of lamps and ballasts. RESERVED.

609.11 Verification of lighting controls. Prior to issuance of a certificate of occupancy, the field inspector shall confirm the installation of lighting controls shown on the approved construction documents. Where a discrepancy is found, the installation shall be reviewed for conformance with the *Energy Code* and Sections 609.2, 609.3, 609.4, 609.5, and 609.6 of this code as applicable.

TABLE 609.8.1.1(1)
LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS
(Maximum 600-Volt Primary)

SINGLE PHASE		THREE PHASE	
kVA Rating	Minimum Efficiency (%)	kVA Rating	Minimum Efficiency (%)
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
—	—	750	98.8
—	—	1000	98.9

1. Dry-type distribution transformers are air-cooled, and do not use oil as a coolant.
2. All efficiency values for low-voltage transformers are at 35 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
3. All efficiency values for medium-voltage transformers are at 50 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
4. Basic impulse insulation level (BIL).

TABLE 609.8.1.1(3)
MEDIUM-VOLTAGE, LIQUID-IMMERSED
DISTRIBUTION TRANSFORMERS
(Maximum 34,500-Volt Primary, Maximum 600-Volt Secondary)

SINGLE PHASE		THREE PHASE	
kVA Rating	Minimum Efficiency (%)	kVA Rating	Minimum Efficiency (%)
10	98.62	15	98.36
15	98.76	30	98.62
25	98.91	45	98.76
37.5	99.01	75	98.91
50	99.08	112.5	99.01
75	99.17	150	99.08
100	99.23	225	99.17
167	99.25	300	99.23
250	99.32	500	99.25
333	99.36	750	99.32
500	99.42	1000	99.36
667	99.46	1500	99.42
883	99.49	2000	99.46
—	—	2500	99.49

1. Dry-type distribution transformers are air-cooled, and do not use oil as a coolant.
2. All efficiency values for low-voltage transformers are at 35 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
3. All efficiency values for medium-voltage transformers are at 50 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
4. Basic impulse insulation level (BIL).

TABLE 609.8.1.1(2)
MEDIUM-VOLTAGE, DRY-TYPE DISTRIBUTION TRANSFORMERS (Maximum 34,500-Volt Primary, Maximum 600-Volt Secondary)

SINGLE PHASE				THREE PHASE			
kVA Rating	20-45 kV BIL Minimum Efficiency (%)	46-95 kV BIL Minimum Efficiency (%)	>96 kV BIL Minimum Efficiency (%)	kVA Rating	20-45 kV BIL Minimum Efficiency (%)	46-95 kV BIL Minimum Efficiency (%)	>96 kV BIL Minimum Efficiency (%)
15	98.10	97.86	—	15	97.50	97.18	—
25	98.33	98.12	—	30	97.90	97.63	—
37.5	98.49	98.30	—	45	98.10	97.86	—
50	98.60	98.42	—	75	98.33	98.12	—
75	98.73	98.57	98.53	112.5	98.49	98.30	—
100	98.82	98.67	98.63	150	98.60	98.42	—
167	98.96	98.83	98.80	225	98.73	98.57	98.53
250	99.07	98.95	98.91	300	98.82	98.67	98.63
333	99.14	99.03	98.99	500	98.96	98.83	98.80
500	99.22	99.12	99.09	750	99.07	98.95	98.91
667	99.27	99.18	99.15	1000	99.14	99.03	98.99
833	99.31	99.23	99.20	1500	99.22	99.12	99.09
—	—	—	—	2000	99.27	99.18	99.15
—	—	—	—	2500	99.31	99.23	99.20

1. Dry-type distribution transformers are air-cooled, and do not use oil as a coolant.
2. All efficiency values for low-voltage transformers are at 35 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
3. All efficiency values for medium-voltage transformers are at 50 percent of nameplate-rated load, determined according to the DOE test procedure. 10 CFR Part 431, Sub-part K, Appendix A.
4. Basic impulse insulation level (BIL).

SECTION 610
SPECIFIC APPLIANCES AND EQUIPMENT

610.1 General. This section provides requirements for appliances and equipment installed in the *building* or on the *building site*. Permanent appliances and equipment shall meet the provisions of Section 610.2.

Exception: Appliances and equipment in compliance with Sections 606 through 609 and those listed in Table 610.1.

TABLE 610.1
APPLIANCES AND EQUIPMENT COVERED BY FEDERAL EFFICIENCY STANDARDS

RESIDENTIAL PRODUCTS	COMMERCIAL PRODUCTS
Battery chargers[a]	Beverage vending machines[a]
Clothes dryers	Commercial clothes washers
Clothes washers	Ice makers
Dehumidifiers	Refrigerators and freezers (packaged)
Dishwashers	Supermarket refrigerators
Refrigerators, refrigerator-freezers, and freezers	Walk-in coolers and freezers
Microwave ovens[a]	
Room air conditioners	
Ranges and ovens	

a. These products currently have no federal standard(s).

NOTE: U.S. Department of Energy rulemakings are underway or scheduled.

610.2 Permanent appliances and equipment. Appliances and equipment that are permanently connected to the *building* energy supply system(s) shall meet the provisions of Sections 610.2.1 through 610.2.4, as applicable. Such appliances and equipment shall be *listed* and *labeled* and installed in accordance with the manufacturer's installation instructions and the provisions and terms of their listing, the *Energy Code, Mechanical Code, Oregon Plumbing Specialty Code* and *Building Code*, and shall be provided with controls and energy monitoring systems as required by this code.

610.2.1 Elevators. Elevator systems shall comply with Sections 610.2.1.1 through 610.2.1.2.3.

610.2.1.1 Lighting. Light sources for the cab interior shall have an efficacy greater than or equal to 50 lumens/watt.

610.2.1.2 Power conversion system. *Power conversion systems* for *traction elevators* shall comply with Sections 610.2.1.2.1 through 610.2.1.2.3.

610.2.1.2.1 Motor. Induction motors with a Class IE2 efficiency rating, as defined by IEC EN 60034-30, or alternative technologies, such as permanent magnet synchronous motors that have equal or better efficiency, shall be used.

610.2.1.2.2 Transmission. Transmissions shall not reduce the efficiency of the combined motor/transmission below that shown for the Class IE2 motor.

Gearless machines shall be assumed to have a 100-percent transmission efficiency.

610.2.1.2.3 Drive. Potential energy released during motion shall be recovered.

610.2.1.3 Ventilation. Cab *ventilation* fans shall have an efficacy greater than or equal to 3.0 CFM per watt (0.085 m^3/min./watt).

610.2.1.4 Standby mode. When the elevator is stopped, not occupied, and with doors closed, lighting, *ventilation* and car displays shall be capable of being de-energized within 5 minutes of stopping, and re-energized prior to opening the doors. Power shall cease to be applied to the door motor after the elevator is stopped, lighting is de-energized, and no one is in the car, and re-energized upon the next passenger arrival. In *buildings* with multiple elevators serving the same floors, not less than half of the elevators shall be capable of switching to sleep, low power mode during periods of low traffic.

610.2.1.5 Guides. All elevator car guides in buildings serving five levels or more shall be of the roller type, in order to reduce frictional energy losses. Counterweights with sliding guides shall be balanced in order to minimize frictional losses associated with the counterweight guides.

610.2.2 Escalators and moving walkways. Escalators and moving walkways shall comply with Sections 610.2.2.1 through 610.2.2.5.

610.2.2.1 Lighting. Light sources including, but not limited to, balustrade lighting, comb-plate lighting and step demarcation lighting, shall have an efficacy of not less than 50 lm/W.

610.2.2.2 Drive system. Induction motors with a Class IE3 efficiency rating, as defined by IEC EN 60034-30, or permanent magnet synchronous motors shall be used.

610.2.2.3 Energy recovery. Down-running escalators equipped with direct variable frequency drives shall use regenerative drives and return recovered energy to the building electrical power system.

610.2.2.4 Handrails. Handrails shall use friction-reducing measures, such as, but not limited to, rollers in newels.

610.2.2.5 Standby mode. During *standby mode*, escalators and moving walkways shall be capable of being automatically slowed to not greater than 50 percent of nominal speed. Escalators and moving walkways shall be capable of being automatically turned off when the *building* is unoccupied or outside of *facility operations*.

610.2.3 Commercial food service equipment. Not less than 50 percent of the aggregate rated power allocated to commercial food service equipment shall be ENERGY STAR-eligible food service equipment including, but not limited to, open deep-fat fryers, hot food holding cabinets, reach-in refrigerators and freezers, solid door refrigerators and freezers defined by ENERGY STAR. Steam cookers, dishwashers, griddles and convection gas and electric ovens shall be ENERGY STAR qualified.

610.2.4 Conveyors. Motors associated with conveyors shall be sized to meet the expected load and designed to run within 90 percent of capacity at all times the conveyor is expected to operate. Conveyor motors shall be provided with sleep mode controls. Two-speed motors and adjustable-speed drives shall be provided where load weights are expected to vary. *Readily accessible* controls shall be provided to allow for *manual* shut off of the conveyor when it is not needed. Conveyor systems shall be designed to use gravity feed when conditions allow and arranged such that long straight runs are provided with as few drives as possible.

610.3 Portable appliances and equipment. RESERVED.

SECTION 611
BUILDING RENEWABLE ENERGY SYSTEMS

611.1 Renewable energy systems requirements. *Buildings* that consume energy shall comply with this section. Each *building* or surrounding lot or *building site* where there are multiple buildings on the *building site* shall be designed and constructed in such a way as to accommodate the future installation of one or more renewable energy systems in accordance with this section. Building project design shall show allocated space and pathways for installation of on-site renewable energy systems and associated infrastructure.

Space designated on plans shall be permanently designated in the building and verified prior to issuance of a certificate of occupancy. Wall mounting space shall be designated with temporary backer board, labeled to designate future equipment. Equipment floor space, including service clearances, shall be painted on floors.

Renewable energy systems shall be designed to meet the requirements of Section 611.2 for *solar photovoltaic* systems, Section 611.3 for wind systems, or Section 611.4 for solar water heating systems, and Section 611.5 for *metering* of these systems as *approved* by the code official.

Exceptions:

1. *Buildings* or *building sites* where there are multiple *buildings* on the *building site* providing at least 2 percent of the total estimated annual energy use of the *building*, or collective *buildings* on the site, with on-site renewable energy using a combination of renewable energy generation systems.
2. Buildings using Section 607.1.1.2 to comply with Section 607.
3. For building occupancies listed below, where at least 10 percent of the *building's* annual estimated hot water energy usage is met by a geothermal or solar water heating system designed, constructed and installed in accordance with manufacturer's instructions.
    a. Group A-2, Restaurants and Banquet halls.
    b. Group F, Laundries.
    c. Group R-1, Boarding houses (transient), Hotels (transient), Motels (transient).
    d. Group R-2 occupancies.

e. Group A-3, Health Clubs and Spas.

f. Group I-2, Hospitals, Mental hospitals and Nursing homes.

611.1.1 Building performance-based compliance. *Buildings* and surrounding property or *building sites* when there are multiple *buildings* on the *building site,* that seek compliance with this code in accordance with Section 602.2.2, performance-based compliance, shall be designed and constructed in such a way as to accommodate the future installation of one or more renewable energy systems that have the capacity to provide not less than 2 percent of the total calculated annual energy use of the *building*, or collective *buildings* on the site, with on-site renewable energy in accordance with Section 603.

611.1.2 Building prescriptive compliance. *Buildings* and surrounding property or *building sites* where there are multiple *buildings* on the *building site,* that seek compliance with this code in accordance with Section 602.2.1, shall be designed and constructed in such a way as to accommodate the future installation of one or more renewable energy systems that have the capacity to provide not less than 2 percent of the total estimated annual energy use of the *building*, or collective *buildings* on the *building site*, with on-site renewable energy by calculation demonstrating that on-site renewable energy production has a rating of not less than 1.75 *Btu*/hr or not less than 0.50 watts per square foot of conditioned floor area, and using any single or combination of renewable energy generation systems.

611.2 Solar photovoltaic systems. *Solar photovoltaic* systems shall be designed and sized to provide not less than 2 percent of the total estimated annual electric energy consumption of the *building*, or collective *buildings* on the *building site.*

611.2.1 Requirements. The installation, inspection, maintenance, repair and replacement of *solar photovoltaic systems* and all system components shall comply with the *Oregon Solar Installation Specialty Code* and the *Oregon Electric Specialty Code.*

611.2.1.1 Roof-mounted solar photovoltaic systems. Where *solar photovoltaic systems* may be installed on a roof, the roof shall be constructed to support the loads imposed by such modules. Sufficient space on the roof shall be set aside to accommodate the clearances from roof features required by the *Oregon Solar Installations Specialty Code*.

611.2.2 Performance verification. Where a photovoltaic system has been installed, to meet either the project elective in Section 303 or Section 607.1.1.2, the systems shall be tested upon installation to verify that the installed system meets the design specifications. A report of the tested performance shall be provided to the *building* owner.

611.3 Wind energy systems. Wind energy systems shall be designed, and sized to provide not less than 2 percent of the total estimated annual electric energy consumption of the *building*, or collective *buildings* on the *building site.*

611.3.1 Installation, location and structural requirements. Wind energy systems shall be located on the *building*, adjacent to the *building*, or on the *building site*.

611.3.1.1 Roof top set back. RESERVED.

611.3.1.2 Roof and wall penetrations. Roof and wall penetrations shall be flashed and sealed to prevent entry of water, rodents and insects according to the *Building Code.*

611.3.1.3 Solar photovoltaic modules. RESERVED.

611.3.1.4 Inverters. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

611.4 Solar water heating equipment. Under this section a building shall be designed and constructed in such a way as to accommodate not less than 10 percent of the building's annual estimated hot water energy usage to be met by on-site solar water heating equipment.

611.5 Renewable energy system performance monitoring and metering. Where installed as a project elective under Section 303 or to meet Section 607.1.1.2, renewable energy systems shall be *metered* in accordance with Section 611.5.1.

611.5.1 Metering. Renewable energy systems shall be metered separately from the building's electrical and fossil fuel meters. Renewable energy systems shall be metered to measure the amount of renewable electric or thermal energy generated on the building site in accordance with Section 604.

611.5.2 Monitoring. RESERVED.

SECTION 612
ENERGY SYSTEMS COMMISSIONING AND COMPLETION

612.1 Mechanical systems commissioning and completion requirements. Prior to final inspection, the building owner or owner's representative shall provide evidence of receipt of a mechanical system's functional performance test, in a preliminary acceptance report, and completion of the mechanical system installation to the code official in accordance with the *Energy Code*. Construction documents shall clearly indicate provisions for testing and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner and to the code official upon request.

612.1.1 Commissioning plan. For buildings over 50,000 square feet (4645 m^2) with complex mechanical systems, a *commissioning* plan shall be developed by a *registered design professional* or approved *entity* and shall include as a minimum all of the following items:

1. A narrative describing the activities that will be accomplished during each phase of *commissioning*, including guidance on who accomplishes the activities and how they are completed.
2. Equipment and systems to be tested including, but not limited to, the specific equipment, appliances or systems to be tested and the number and extent of tests.
3. Functions to be tested including, but not limited to, calibrations and economizer controls.

4. Conditions under which the test shall be performed including, but not limited to, affirmation of winter and summer design conditions and full outside air.
5. Measurable criteria for performance.

612.1.2 Systems adjusting and balancing. HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the product specifications. Test and balance activities shall include as a minimum, the provisions of Sections 612.1.2.1 and 612.1.2.2.

612.1.2.1 Air systems balancing. Each supply air outlet and zone terminal device shall be equipped with a means for air balancing in accordance with the *Mechanical Code*. Discharge dampers are prohibited on constant volume fans and variable volume fans with motors of 10 hp (18.6 kW) and larger. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.

Exception: Fans with fan motor horsepower of 1 hp or less.

612.1.2.2 Hydronic systems balancing. Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the capability to measure pressure across the pump, or shall have test ports at each side of each pump.

Exceptions:

1. Pumps with pump motors of 5 hp or less.
2. Where throttling results in not greater than 5 percent of the nameplate horsepower draw above that required if the impeller were trimmed.

612.1.3 Functional performance testing. Construction documents shall require functional testing of the equipment and systems. Results shall be reported in a Preliminary Acceptance Report per Section 612.1.4. Functional performance testing shall be in accordance with the requirements of Sections 612.1.3.1, 612.1.3.2 and 612.1.3.3. Parties responsible for testing shall be designated on the construction documents.

612.1.3.1 Equipment. Equipment functional performance testing shall demonstrate the installation and operation of components, systems and system-to-system interfacing relationships in accordance with *approved* plans and specifications such that operation, function and maintenance serviceability for each of the commissioned systems are confirmed. Testing shall include all specified modes of control and *sequence of operation*, including under full-load, part-load and all of the following emergency conditions:

1. Each mode as described in the sequence of operation.
2. Redundant or *automatic* back-up mode.
3. Performance of alarms.
4. Mode of operation upon a loss of power and restoration of power.

612.1.3.2 Controls. HVAC control systems shall be tested to document that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with the *approved* plans and specifications. *Sequences of operation* shall be functionally tested to document that they operate in accordance with the *approved* plans and specifications.

612.1.3.3 Economizers. Air economizers shall undergo a functional test to determine that they operate in accordance with Section 607.6.1.1 and manufacturer's specifications.

612.1.4 Preliminary acceptance report. A preliminary report of *functional* test procedures and results shall be certified by the *registered design professional* or *approved entity* and provided to the *building* owner. The report shall be identified as "Preliminary Acceptance Report" and shall identify all of the following:

1. Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.
2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
3. Climatic conditions required for performance of the deferred tests.

612.1.4.1 Acceptance. Buildings, or portions thereof, shall not pass the final mechanical inspection until such time as the code official has received a letter of transmittal from the building owner acknowledging that the building owner has received the Preliminary Acceptance Report.

612.1.4.2 Copy. RESERVED.

612.1.4.3 Certification. RESERVED.

612.1.5 Completion requirements. The *construction documents* shall specify that the requirements described in this section be provided to the *building* owner within 90 days of the date of receipt of the *certificate of occupancy.*

612.1.5.1 Drawings. *Construction documents* shall include the location of and performance data pertaining to each piece of equipment.

612.1.5.2 Manuals. An operating and maintenance manual in accordance with industry-accepted standards shall be provided and shall include all of the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the *building* project. Required routine maintenance shall be clearly identified.
3. Names and addresses of not less than one *service agency.*

For buildings with complex mechanical systems over 50,000 square feet (4645 m^2), a systems manual shall be provided and shall include all of the following:

1. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics and control sequence descriptions. Desired or field-determined set-points shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.
2. A complete narrative of how each system is intended to operate, including recommended set-points, seasonal change-over information and emergency shutdown operation.
3. Control sequence descriptions for lighting, domestic hot water heating and all renewable energy systems complete with a description of how these systems connect to, and are controlled in conjunction with, the overall building system.

612.1.5.3 System balancing report. A written report describing the activities and measurements completed in accordance with Section 612.1.2 shall be provided.

612.1.5.4 Final commissioning report (Project Elective). If selected by the owner as a project elective under Section 303, a complete report of test procedures and results identified as "Final Commissioning Report" shall be completed and provided to the building owner. The report shall include all of the following:

1. Results of all functional performance tests.
2. Disposition of all deficiencies found during testing, including details of corrective measures used or proposed.
3. All functional performance test procedures used during the *commissioning* process including measurable criteria for test acceptance, provided herein for repeatability.

Exception: Deferred tests that were not performed at the time of report preparation because of climatic conditions.

612.1.5.5 Post occupancy re-commissioning (Project Elective). If selected by the owner as a project elective under Section 303, the *commissioning* activities specified in Sections 612.1.3 and 612.1.5.4 shall be repeated 18 to 24 months after the issuance of a certificate of occupancy. Systems and control devices that are not functioning properly shall be repaired or replaced. Adjustments to calibration settings shall be documented. This documentation shall be provided to the *building* owner.

612.2 Post-commissioning sequence of operation (Project Elective). If selected by the owner as a project elective under Section 303, plans and specifications shall require that a *sequence of operation* shall be developed and finalized upon final *commissioning*, when the operational details are initialized and validated. The *sequence of operation* shall be the final record of system operation, and shall be included on the control diagram "as-builts," or as part of the education and operation and maintenance document that is provided to the owner.

612.3 Lighting and electrical systems functional testing and completion requirements. Prior to issuance of a *certificate of occupancy,* the *registered design professional* or approved entity shall provide evidence of lighting and electrical systems *functional testing* in accordance with the *Energy Code* and the provisions of this section.

Construction documents shall specify the provisions for *testing* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner and made available to the *code official* upon request in accordance with Sections 612.3.4 and 612.3.5.

612.3.1 Pre-construction documentation, lighting. Construction and owner education documents shall include floor plans, diagrams and notations of sufficient clarity describing the types of, location and operational requirements of all lighting controls, including a *sequence of operation* and preliminary intended set points for all dimming systems and *automatic daylight controls,* demonstrating conformance to the provisions of this code, relevant laws, ordinances, rules and regulations, as *approved by the code official.*

612.3.2 Verification. The registered design professional or *approved entity* conducting *functional testing* shall verify that controls have been installed in accordance with the *approved construction documents.* Any discrepancies shall be reviewed for compliance with Section 609 and the requirements of Section 505.2 of the *Energy Code.* The registered design professional or approved entity shall confirm the installation of luminaires (type); lamps (type and wattage) and ballasts (type and performance) for not less than one representative luminaire of each type, for consistency with the approved *construction documents.*

612.3.3 Functional testing. Lighting controls shall be tested in accordance with this section.

612.3.3.1 Occupant sensors. It shall be verified that the functional testing in accordance with *Energy Code* Section 505.2 has been performed.

612.3.3.2 Automatic daylight controls. *Automatic daylight controls* shall be tested in accordance with all of the following:

1. It shall be verified that the placement and orientation of each sensor is consistent with the manufacturer's installation instructions. If not, the sensor shall be relocated or replaced;
2. Control systems shall be initially calibrated to meet settings and design intent established in the construction *documents*;
3. Prior to calibration of systems controlling dimmable luminaires, all lamps shall be seasoned in accordance with the recommendations of the lamp manufacturer;
4. Where located inside *buildings*, calibration of open-loop *daylight controls,* which receive illumination from natural light only, shall not occur until fenestration shading devices such as blinds or shades have been installed and commissioned;
5. Calibration of closed-loop *daylight controls,* that receive illumination from both natural and artificial light, shall not occur until furniture systems and interior finishes have been installed, and any fenestration shading devices such as blinds or shades have been installed and commissioned; and
6. Calibration procedures shall be in accordance with the manufacturer's installation instructions.

612.3.3.3 Time switch and programmable schedule controls. Lighting controls installed in accordance with Section 609 shall be programmed. Scheduling shall incorporate weekday, weekend and holiday operating times, including leap year and daylight savings time corrections. It shall be verified that system overrides work and are located in compliance with Section 505.2 of the *Energy Code*.

612.3.3.4 Dimming systems with preset scenes. For programmable dimming systems it shall be verified that *automatic* shutoff and manual overrides are working and that programming is complete. Prior to programming, all lamps shall be seasoned in accordance with the recommendations of the lamp manufacturer.

612.3.3.5 Egress lighting interlock. For buildings with egress lighting required to be shut off during unoccupied periods per Section 505.2.1.1 of the *Energy Code*, the operation of interlocks and relays to turn on the egress lights during emergency conditions shall be tested and verified.

612.3.4 Post-commissioning documentation project elective. If selected by the owner as a project elective under Section 303, the following documentation shall be provided to the *building* owner in accordance with Section 903.

1. Settings determined during *commissioning* activities outlined in Section 612.3.3.
2. A narrative describing the intent and functionality of all controls including any capability for users to override a schedule or master command.
3. Specification sheets for all lighting equipment and controls.
4. Operation manuals for each lighting control device. Required maintenance and maintenance schedules shall be clearly identified. Documentation and instructions necessary for *building* maintenance personnel to maintain and re-calibrate lighting systems and controls.
5. An annual inspection schedule for lighting controls.
6. Troubleshooting information for fluorescent dimming systems and the remediation of switching issues such as false-ons and false-offs.

612.3.5 Post occupancy re-commissioning project elective. If selected by the owner as a project elective under Section 303, the *commissioning* activities in Section 612.2.3 shall be repeated 18 to 24 months after issuance of the certificate of occupancy. Control devices that are not functioning properly shall be repaired or replaced. Adjustments to calibration settings shall be documented. This documentation shall be provided to the *building* owner.

612.4 Building envelope systems commissioning and completion requirements. Prior to issuance of a *certificate of occupancy,* the *registered design professional* or *approved entity* shall provide evidence of *building thermal envelope* systems *commissioning* and completion to the building owner in accordance with the *Energy Code* and the provisions of this section.

Construction documents shall specify the provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the building owner and made available to the *code official* upon request in accordance with Sections 612.4.1 and 612.4.2.

612.4.1 Pre-construction documentation, building thermal envelope. Construction documents shall indicate the location, nature and extent of the work proposed and show the functional requirements and operation of all *building thermal envelope* systems demonstrating conformance to the provisions of this code, relevant laws, ordinances, rules and regulations, as *approved* by the *code official.*

612.4.2 Verification. The registered design professional or *approved entity* conducting *commissioning* shall verify that *building thermal envelope* systems have been installed in accordance with the *approved construction documents.* Any discrepancies shall be reviewed for compliance with the requirements of the *Energy Code* and this code.

SECTION 613
JURISDICTIONAL REQUIREMENTS AND PROJECT ELECTIVES

613.1 General. Section 613 addresses *project electives* related to energy conservation and efficiency. *Project electives* shall not be mandatory unless selected by the owner or *design professional in responsible charge* and indicated in the Project Elective Checklist in accordance with Section 303.4.

613.2 Post certificate of occupancy energy use reporting. The owner participates in the US Department of Energy's ENERGY STAR Portfolio Manager program and reports annual energy use.

613.2.1 Purpose. The purpose of this section is to provide for the uniform reporting and display of the *total annual net energy use* associated with *building* operations and *building sites.*

613.2.2 Intent. The intent of these requirements is to provide for the ongoing reporting and display of the *total annual net energy use* of the *building* and its systems to document ongoing compliance with the provisions of Sections 602 and 603.

613.2.3 Reporting. Reports in accordance with Section 613.2.3.1 shall be generated.

613.2.3.1 Annual net energy use. The energy use associated with the operation of the *building* and the *buildings* on the site, as determined in accordance with Section 603.1, shall be reported by the *building* owner or the owner's registered agent to the ENERGY STAR Portfolio Manager program for release and reporting of the building's annual Energy Use Intensity (EUI).

Where there are multiple *buildings* on a *building site,* each *building* shall have its energy use reported separately. Where there are energy uses associated with the *building site* other than the *buildings* on the site, the energy use for the *building site* shall be reported separately.

Energy use for the previous year shall cover the complete calendar year and be reported on, or before, March 1st of the following year.

613.3 Energy use reduction project electives. *Project electives* for *buildings* pursuing performance-based compliance in accordance with Section 602.3.2 shall be in accordance with calculation procedures specified in Section 603.3. (One project elective for designing to 25 percent better than the *Energy Code.* A second project elective for designing to 30 percent better than the *Energy Code*).

613.4 Mechanical systems project elective. *Buildings* seeking a mechanical systems project elective in accordance with Table 303.1 and Section 303.4 shall comply with Sections 613.4.1 through 613.4.5.

613.4.1 Prescriptive path. The *building* shall be designed prescriptively in accordance with Section 602.2.1.

613.4.2 Mechanical equipment. Mechanical equipment shall comply with Sections 613.4.2.1 through 613.4.2.4 to achieve the mechanical system's *project elective.*

613.4.2.1 Heating equipment. For heating equipment, the part-load efficiency of the equipment shall be not less than 10 percent greater than the part-load efficiencies shown in the applicable tables of Section 606, the *Energy Code*, or ASHRAE 90.1, or the equipment shall meet ENERGY STAR criteria, as applicable.

613.4.2.2 Cooling equipment. For cooling equipment, the part-load efficiency of the equipment shall be not less than 10 percent greater than the part-load efficiencies shown in the applicable tables of Section 606, the *Energy Code,* or ASHRAE 90.1, or the equipment shall meet ENERGY STAR criteria.

613.4.2.3 Geothermal heat pumps. Geothermal heat pumps shall meet the provisions of Table 613.4.2.3 based on the applicable referenced test procedure.

613.4.2.4 Multi-stage geothermal heat pumps. The efficiency of multi-stage geothermal heat pumps shall meet the provisions of Table 613.4.2.3 based on the applicable referenced test procedure.

TABLE 613.4.2.3
ENERGY-EFFICIENCY CRITERIA FOR GEOTHERMAL SOURCE HEAT PUMPS

PRODUCT TYPE	MINIMUM EER	MINIMUM COP	TEST PROCEDURE
Water-to-air closed loop	14.1	3.3	ISO 13256-1
Water-to-air open loop	16.2	3.6	ISO 13256-1
Water-to-water closed loop	15.1	3.0	ISO 13256-2
Water-to-water open loop	19.1	3.4	ISO 13256-2
Direct expansion (DX) or direct geoExchange (DGX)	15.0	3.5	AHRI 870

613.4.3 Duct insulation. Ducts shall be insulated to R-8 or greater where located in unconditioned spaces and R-11 minimum where located outside of the *building structure.* Where located within a *building* envelope assembly, the duct or plenum shall be separated from the *building* exterior or unconditioned or exempt spaces by R-8 insulation or greater.

613.4.4 Duct system testing. Duct systems shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* and shall have a rate of air leakage (CL) less than or equal to 4 as determined in accordance with Equation 5-2 of the *Energy Code*.

606.4.4.1 Documentation. Documentation shall be furnished by the designer demonstrating that representative sections totaling not less than 50 percent of the duct area have been tested and that all tested sections meet the requirements of Section 613.4.4.

613.4.5 Service water heating equipment. The efficiency of the service water heating equipment shall be not less than 10 percent greater than the efficiencies shown in the *Energy Code* and ASHRAE 90.1 or the service water heating equipment shall be ENERGY STAR qualified.

613.5 Service water heating project elective. Buildings seeking a service water heating project elective in accordance with Table 303.1 and Section 303.4 shall comply with Sections 613.5.1 through 613.5.3.

613.5.1 Prescriptive path. RESERVED.

613.5.2 Occupancy. The building shall be designed to serve one of the following occupancies:

1. Group A-2, Restaurants and Banquet halls;
2. Group F, Laundries;
3. Group R-1, Boarding houses (transient), Hotels (transient), Motels (transient);
4. Group R-2, *buildings*;
5. Group A-3, Health Clubs and Spas; and
6. Group I-2, Hospitals, Mental hospitals and Nursing homes.

613.5.3 Service water heating efficiency. The efficiency of the service water heating equipment shall be at least 10 percent greater than the efficiencies shown in the *Energy Code* and ASHRAE 90.1 or the service water heating equipment shall be ENERGY STAR qualified.

613.6 Lighting system efficiency project elective. Buildings seeking a lighting system efficiency project elective in accordance with Table 303.1 and Section 303.4 shall comply with Sections 613.6.1 through 613.6.3.

613.6.1 Prescriptive path. The building shall be designed prescriptively in accordance with Section 602.3.1.

613.6.2 Interior lighting system efficiency. The interior connected lighting power shall be 10 percent less than the allowance determined in accordance with Section 505.5 of the *Energy Code.*

613.6.3 Exterior lighting system efficiency. The exterior connected lighting power shall be 10 percent less than the allowance determined in accordance with Section 505.6 of the *Energy Code.*

613.7 Passive design project elective. *Buildings* seeking a passive design *project elective* in accordance with Table 303.1 and Section 303.4 shall comply with Sections 613.7.1 and 613.7.2.

613.7.1 Performance path. The building shall be designed using the performance path in accordance with Section 602.2.2.

613.7.2 Passive design provisions. The simulation of energy use performed pursuant to Section 603 shall document that not less than 40 percent of the annual energy use reduction realized by the *proposed design has* been achieved through passive heating, cooling and ventilation design, as compared to the *standard reference design.* Passive heating and cooling shall use strategies including, but not limited to, *building* orientation, fenestration provisions, material selection, insulation choices, overhangs, shading means, microclimate vegetation and water use, passive cooling towers, natural heat storage, natural *ventilation* and thermal mass.

613.8 Full commissioning project elective. Buildings seeking a full commissioning elective shall develop a commissioning plan per Section 612.1.1 and comply with all of Section 612, including Sections 612.1.5.4, 612.1.5.5, 612.2, 612.3.4 and 612.3.5.

613.9 Building energy renewable systems project elective. Each building or building site seeking this project elective shall be equipped with one or more renewable energy systems in accordance with Sections 611.2, 611.3 and 611.4 that have the capacity to provide at least 2 percent of the annual energy used within the building for mechanical and service water heating equipment and lighting regulated in Chapter 5 of the IECC, and that capacity shall be demonstrated in accordance with Section 611.1.1 or 611.1.2. These systems shall be metered in accordance with Section 604.4.7.

> **Exception:** Buildings using Section 607.1.1.2 to comply with Section 607 shall provide at least 4 percent of the annual energy use within the building for mechanical and service water heating equipment and lighting regulated in Chapter 5 of the IECC.

613.9.1 Building performance-based compliance. Performance-based compliance shall be based on building annual energy use calculations in accordance with Section 603.

613.9.2 Building prescriptive compliance. Prescriptive compliance shall be based on building annual energy use calculations in accordance with Section 603 or demonstrate that the renewable energy system provides not less than 0.30 watts per square foot of conditioned floor area.

613.10 Enhanced envelope. Each building seeking this project elective shall increase the envelope values 10 percent over the prescriptive requirements listed in Section 606.1.