Guam Building Energy Code

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1. PURPOSE

The purpose of this code is to provide minimum requirements for the energy-efficient design of residential commercial and government buildings.

2. SCOPE

2.1 This code provides minimum energy-efficient requirements for the design and construction of (a) new buildings and their systems; (b) new portions of buildings and their systems, (c) new systems and equipment in existing buildings, and (d) major renovations. Major renovations are defined as projects where the estimated cost of construction is more than 50% of the appraised value of the structure.

2.2 The provisions of this code apply to (a) building envelopes, except for unconditioned storage spaces or warehouses; and (b) building systems and equipment, including ventilating, and air conditioning, service water heating, and interior and exterior lighting

2.3 The provisions of this code do not apply to: (a) buildings that do not use either electricity or fossil fuel; or (b) equipment and portions of building systems that use energy primarily for industrial, manufacturing or commercial processes.

2.4 Where specifically noted in this code, certain other buildings or elements of buildings shall be exempt.

2.5 Where this code is found to conflict with safety, health or environmental codes, the safety, health or environmental codes shall govern.

3. ADMINISTRATION AND ENFORCEMENT

3.1 Compliance Requirements

3.1.1 **New Buildings**. New buildings shall comply with either the provisions of § 4 through § 7 of this code or the energy cost budget method in Section 13 of ASHRAE/IESNA Standard 90.1-1989.

3.1.2 **Additions to Existing Buildings.** Additions shall comply with the provisions of § 4 through § 7 applicable to building envelope, heating, ventilating, air-conditioning, service water heating, power, lighting, and other systems and equipment. Compliance may be demonstrated in one of three ways:

(a) The addition alone shall comply with the applicable requirements;

(b) The addition, together with the entire existing building, shall comply with the requirements of this code that would apply to the entire building, as if it were a new building; or,

(c) The addition, together with the existing building, shall use no more energy than the existing building together with an addition which complies with the literal requirements of the code.

Exception: When space conditioning or service water heating to an addition are provided by existing systems, the existing systems and equipment for such space conditioning and service water heating need not comply with this code. However, any new equipment installed must comply with specific requirements applicable to that equipment.

3.1.3 **Alterations to Existing Buildings**. Portions of a building and its systems that are being altered shall meet the provisions of § 4 through § 7. The specific requirements for alterations are described in the following subsections.

3.1.3.1 Envelope. Alterations to the building envelope shall comply with the requirements of § 4 for insulation, moisture control, air leakage, and glazing applicable to the portions of the buildings and its systems being altered.

Exceptions: The following alterations need not comply with these requirements provided such alterations do not increase the energy usage of the building:

(a) replacement of glass in existing sash and frame, provided the area-weighted solar heat gain coefficient (SHGC) will be equal to or lower than before the glass replacement,

(b) modifications to roof/ceiling, wall, or floor cavities, which are insulated to full depth with insulation having a minimum nominal value of R-3.0/in.,

(c) modifications to walls and floors without framing cavities, and

(d) replacement of a roof membrane where either the roof sheathing or roof insulation is not exposed or, if there is existing roof insulation, below the roof deck.

3.1.3.2 Ventilation and Air Conditioning. Alterations to building ventilating, and air-conditioning equipment or systems shall comply with the requirements of § 5 applicable to the portions of the building and its systems being altered. Any new equipment or control devices installed in conjunction with the alteration shall comply with the specific requirements applicable to that equipment or control device.

3.1.3.3 Service Water Heating. Alterations to building service water heating equipment or systems shall comply with the requirements of § 6 applicable to the portions of the building and its systems being altered. Any new equipment or control devices installed in conjunction with the alteration shall comply with the specific requirements applicable to that equipment or control device.

3.1.3.4 Lighting. Alterations to building lighting equipment or systems shall comply with the requirements of § 7 applicable to the portions of the building and its systems being altered. New lighting systems, including controls, installed in an existing building and any change of building category shall also be considered an alteration. Any new equipment or control devices installed in conjunction with the alteration shall comply with the specific requirements applicable to that equipment or control device.

Exception to § 3.1.3.4: Alterations that replace less than 50% of the luminaires in a space need not comply with these requirements provided such alterations do not increase the connected lighting load.

3.2 Administrative Requirements

Administrative requirements relating to permit requirements, enforcement, interpretations, claims of exemption, approved calculation methods, and rights of appeal are specified by the building official.

3.3 Compliance Documents

3.3.1 General. Plans, specifications, engineering calculations, diagrams, reports, and other data shall constitute the compliance documents.

3.3.2 Construction Details. Compliance documents shall show all pertinent data and features of the building, equipment, and systems in sufficient detail to permit an evaluation by the building official relative to this code.

3.3.3 Supplemental Information. The building official may require supplemental information necessary to verify compliance with this code, such as calculations, worksheets, compliance forms, vendor literature, or other data.

4. ENVELOPE

4.1 General

4.1.1 Scope. The envelope requirements apply to all enclosed buildings, except unconditioned factories, storage spaces, and warehouses.

4.1.2 Compliance. The building envelope shall comply with the mandatory provisions of § 4.2 and either the prescriptive criteria of § 4.3 or the trade-off procedures of § 4.4.

4.2 Mandatory Provisions

4.2.1 Insulation. Insulation materials shall be installed to achieve proper densities, maintain clearances, and maintain rated R-value of insulation. Exception: Insulation may be compressed at the structural support for draped applications in metal buildings.

4.2.2 Moisture Control. The building envelope shall be designed to prevent moisture migration that leads to deterioration of the insulation or equipment damage.

4.2.3 U-factors. U-factors shall be calculated using procedures consistent with the ASHRAE Fundamentals, 1997.

4.2.4 Building Envelope Sealing. The following areas of the enclosed building envelope shall be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

(a) joints around fenestration and door frames

(b) openings between walls and foundations and between walls and roof and wall panels

(c) openings at penetrations of utility services through, roofs, walls, and floors

(d) site-built fenestration and doors

(e) building assemblies used as ducts or plenums

(f) all other openings in the building envelope.

4.2.5 Solar Heat Gain Coefficient (SHGC). SHGC shall be determined in accordance with NFRC 200. Visible light transmittance shall be determined in accordance with NFRC 300. Exception: Shading coefficient multiplied by 0.86 is an acceptable alternate for determining SHGC.

4.2.6 Fenestration and Doors Air Leakage. Air leakage for manufactured fenestration and doors shall not exceed 0.5 cfm/ft^2 when determined in accordance with NFRC 400 or ASTM E283.

4.2.7 High Albedo Roof Surface. Approved high albedo roof surfaces (typically white in color and smooth in texture) shall have a minimum total solar reflectance when tested according to ASTM E-903 of no less than 0.70. The test sample shall also be tested for its infrared emittance using ASTM E-408 and have an emittance no less than 0.75. Testing shall be performed by an independent laboratory. The roof surface must have a slope of at least ¼ inch per foot of run.

4.3 Prescriptive Building Envelope Requirements

4.3.1 Roofs must meet the requirements of Table 4.3.1.

Table 4.3.1

Class	Nonresidential and High-Rise Residential	Low-Rise Residential
Mass	(a) High albedo roof surface; (b) R-11 Insulation in interior furring space; (c) 2 inches of continuous insulation; or (d) any other construction with a U-factor less than or equal to 0.12.	(a) High albedo roof surface; (b) R-11 Insulation in interior furring space; (c) 2 inches of continuous insulation; or (d) any other construction with a U-factor less than or equal to 0.12.
Metal Buildings	(a) 6 inches of insulation; or (b) any other construction with a U-factor less than or equal to 0.07	(a) 6 inches of insulation; or (b) any other construction with a U-factor less than or equal to 0.07
Other Roofs	(a) R-19 insulation or (b) any other construction with a U-factor less than or equal to 0.06	(a) R-19 insulation or (b) any other construction with a U-factor less than or equal to 0.06
Mass roofs include concrete of 4 inches or greater thickness or any other construction with an HC greater than 7.0 or a weight greater than 35 lb/ft^2.		

4.3.2 Walls must meet the requirements of Table 4.3.2.

Table 4.3.2

Class	Nonresidential and High-Rise Residential	Residential
Mass	No requirement	No requirement
Metal Buildings	(a) 3 inches of insulation or (b) any other construction with a U-factor less than or equal to 0.15	(a) 3 inches of insulation or (b) any other construction with a U-factor less than or equal to 0.15
Metal Framed	(a) R-11 cavity insulation; or (b) any other construction with a U-factor less than or equal to 0.14	(a) R-11 cavity insulation; or (b) any other construction with a U-factor less than or equal to 0.14
Other Walls	(a) R-11 cavity insulation; or (b) any other construction with a U-factor less than or equal to 0.10	(a) R-11 cavity insulation; or (b) any other construction with a U-factor less than or equal to 0.10
A mass wall has an HC greater than 7.0 or a weight greater than 35 lb/ft^2.		

4.3.3 Windows. Glazing products must meet the requirements of Table 4.3.3. Area is limited to a maximum of 40% of the gross wall area.

Table 4.3.3

Building Type	Window Wall Ratio	Un-Shaded	Partially Shaded	Well Shaded or North Facing
Nonresidential or high-rise residential	Less than 5%	No Requirement	No Requirement	No Requirement
	5% - 25%	Special Coated Glass	Tinted Glass	No Requirement
	More than 25%	Special Coated Glass	Special Coated Glass	Tinted Glass
Low-rise residential	All	Tinted Glass	No Requirement	No Requirement

1. Window wall ratio is the ratio of the total window area of the building, measured to the outside of the frame, to the gross exterior wall area.
2. A north facing window is one that faces within 22.5 degrees of true north.
3. Partially shaded windows are those that are protected from direct sun for the majority of the time. Shading can be provided by overhangs, side fins, mature trees, or other devices. Qualifying overhangs must have a projection factor greater than or equal 0.5 and the overhang must extend past the window jambs a distance at least equal to the overhang projection. Qualifying sidefins must have a projection factor greater than or equal 0.5 and the side fin must extend above the window head a distance at least equal to the side fin projection.
4. Well shaded windows are those that are more completely protected from direct sun. Shading can be provided by overhangs, side fins, mature trees, or other devices. Qualifying overhangs must have a projection factor greater than or equal 1.0 and the overhang must extend past the window jambs a distance at least equal to the overhang projection. Qualifying sidefins must have a projection factor greater than or equal 1.0 and the side fin must extend above the window head a distance at least equal to the side fin projection.
5. Tinted glass includes all glazing products with a bronze, green, gray or blue integral tint; clear glass with a coating or film; or any other glazing product that has a solar heat gain coefficient (SHGC) equal to or less than 0.61 or a shading coefficient (SC) less than or equal to 0.71.
6. Special coated glass includes glass with reflective coatings or films that have a solar heat gain coefficient (SHGC) equal to or less than 0.43 or a shading coefficient (SC) less than or equal to 0.50.

4.3.4 Skylights. Area is limited to a maximum of 5% of the gross area. Glazing products must meet the requirements of the following table.

Table 4.3.4

Skylight/Roof Ratio	Nonresidential or High-Rise Residential	Low-Rise Residential
Less Than 2%	No Requirement	No Requirement
2% - 5%	Tinted Glass	No Requirement

1. Tinted glass includes all glazing products with a bronze, green, gray or blue integral tint; clear glass with a coating or film, or any other glazing product that has a solar heat gain coefficient (SHGC) equal to or less than 0.61 or a shading coefficient (SC) less than or equal to 0.71.

4.4 Building Envelope Trade-Off Option

The building envelope complies with the code if the proposed building satisfies the Mandatory Requirements and the envelope performance factor of the proposed building is less than or equal to the envelope performance factor of the budget building.

4.4.1 The envelope performance factor shall be calculated using the following equations.

$$EPF_{Total} = EPF_{Roof} + EPF_{Wall} + EPF_{Fenest}$$

where

$$EPF_{Roof} = c_{Roof,Mass} \sum_{s=1}^{n} U_s A_s \alpha_s + c_{Roof,MtlBldg} \sum_{s=1}^{n} U_s A_s \alpha_s + c_{Roof,Other} \sum_{s=1}^{n} U_s A_s RBF_s$$

$$EPF_{Wall} = c_{Wall,Mass} \sum_{s=1}^{n} U_s A_s + c_{Wall,MtlBldg} \sum_{s=1}^{n} U_s A_s + c_{Wall,MtlFrm} \sum_{s=1}^{n} U_s A_s + c_{Wall,Other} \sum_{s=1}^{n} U_s A_s$$

$$\begin{aligned} EPF_{Fenest} = {} & c_{Fenest,North} \sum_{w=1}^{n} A_w SHGC_w M_w + \\ & c_{Fenest,East} \sum_{w=1}^{n} A_w SHGC_w M_w + \\ & c_{Fenest,South} \sum_{w=1}^{n} A_w SHGC_w M_w + \\ & c_{Fenest,West} \sum_{w=1}^{n} A_w SHGC_w M_w + \\ & c_{Fenest,Skylight} \sum_{s=1}^{n} A_s SHGC_s \end{aligned}$$

where

EPF_{Roof} Envelope performance factor for roofs. Other subscripts include walls and fenestration.

A_s, A_w The area of a specific envelope component referenced by the subscript "s" or for windows the subscript "w".

$SHGC_w$ The solar heat gain coefficient for windows (w). $SHGC_s$ refers to skylights.

M_w A multiplier for the window SHGC that depends on the projection factor of an overhang or sidefin. These values are determined by the procedures in § 4.4.2.

U_s The U-factor for the envelope component referenced by the subscript "s".

RBF_s Radiant barrier factor for roof surface "s". A radiant barrier factor (RBF) of 0.33 shall be assumed for roof constructions with a qualifying radiant barrier, otherwise RBF shall be assumed to be 1.00.

α_s For mass and metal building roofs, an absorptance (α) of 0.70 shall be assumed for roofs that do not qualify as high albedo. For high albedo roofs, an absorptance (α) of 0.30 shall be assumed. The coefficients for use in the EPF equations are contained in Table 4.4.1.

$c_{Roof,Mass}$ A coefficient for the "Roof, Mass" class of construction. Values of "c" are taken from Table 4.4.1 for each class of construction.

Table 4.4.1 - Envelope Performance Factor Coefficients		
	Guam	
Component, Class	Daytime	24-Hour
Roofs, Mass	1.47	3.61
Roofs, MtlBldg	15.83	25.26
Roofs, Other	2.84	3.82
Wall, Mass	2.53	6.14
Wall, MtlBldg	6.36	9.28
Wall, MtlFrm	6.36	9.28
Wall, Other	6.36	9.28
Fenest, East	53	86
Fenest, North	31	51
Fenest, South	58	98
Fenest, West	50	85
Fenest , Skylights	101	163

4.4.2 Credits for fixed shading devices (M) such as overhangs or side fins shall be calculated using the following equation. A separate calculation shall be made for each orientation and unique shading condition.

$$M = a \cdot PF^2 + b \cdot PF + 1$$

Table 4.4.2 - Overhang and Side Fin Coefficients				
		Guam		
Device	Coefficient	North	South	East/West
Overhangs	a	0.16	0.21	0.10
	b	-0.61	-0.83	-0.58
Side Fins	a	0.23	0.12	0.14
	b	-0.74	-0.59	-0.52

4.4.3 The following rules shall be used to define the budget building.

a. The budget building shall have the same building floor area, gross wall area and gross roof area as the proposed design. If the building has both 24-hour and daytime occupancies, the distribution between these shall be the same as the proposed design.

b. The U-factor of each envelope component shall be equal to the criteria from § 4.3 for each class of construction.

c. The vertical fenestration area shall be equal to the proposed design or 40% of the gross exterior wall area, which ever is less. The skylight area shall be equal to the proposed design or 5% of the gross exterior roof area, which ever is less.

d. The SHGC of each window or skylight component shall be equal to the criteria from § 4.3.

5. VENTILATION AND AIR CONDITIONING

5.1 General

All mechanical equipment and systems serving the building cooling, or ventilating needs shall meet the requirements of this section. The requirements of this section apply to ventilating and cooling systems that:

(a) use unitary packaged or split-system air conditioners that are either air-cooled or evaporatively cooled,

(b) serve a single thermal zone

(c) have a cooling capacity less than 65,000 Btu/h, and

(d) do not have a humidistats.

Ventilating and air conditioning systems that do not satisfy the above requirements shall be designed in accordance with ASHRAE/IESNA Standard 90.1-1989.

5.2 Requirements.

5.2.1 The system shall be controlled by a thermostat.

5.2.2 Systems serving spaces other than hotel/motel guest rooms or low-rise residential buildings having a cooling capacity greater than 17,000 Btu/h and a supply fan motor power greater than 3/4 hp shall be provided with a timeclock that (1) can start and stop the system under different schedules for three different day-types per week, (2) is capable of retaining programming and time setting during a loss of power for a period of at least 10 hours, (3) includes an accessible manual override that allows temporary operation of the system for up to 2 hours, and (4) is capable of temperature setback up to 85°F during off hours.

5.2.3 Systems with greater than 3000 cfm supply fan capacity shall have optimum start controls. Exception: hotel/motel guest rooms or low-rise residential buildings.

5.2.4 Refrigerant suction piping on split systems shall have at least 1/2 in. cellular foam or fiberglass insulation. Insulation exposed to weather shall be protected by aluminum sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above, or be painted with water retardant paint.

5.2.5 Ductwork shall be insulated in accordance with Table 5.2.5.

Table 5.2.5

	Required Insulation[1]	
Duct Location	Supply Ducts	Return Ducts
Exterior	R-6	R-3.5
Ventilated Attic	R-6	R-3.5
Unventilated Attic with Ceiling Insulation	R-8	R-3.5
Unventilated Attic with Roof Insulation	R-3.5	No Requirement
Unconditioned Space[2]	R-3.5	No Requirement
Indirectly Conditioned Space[3]	No Requirement	No Requirement
Buried	R-3.5	No Requirement

1. Insulation R-value is measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75° F at the installed thickness
2. Includes crawlspaces, both ventilated and non-ventilated
3. Includes return air plenums with or without exposed roofs above.

5.2.6 Ductwork shall be sealed in accordance with Table 5.2.6.

Table 5.2.6

	Supply Ducts			
Duct Location	< 2 inch w.g.	≥ 2" inch w.g.	Exhaust Ducts	Return Ducts
Outside Conditioned Space	←	←	None	←
Unconditioned Spaces	↑	←	None	→
Indirectly Conditioned Spaces	→	↑	→	None
Return Air Plenums	→	↑	→	None
Cooled Spaces	None	→1	→	None

← All joints and longitudinal seams, and at all duct wall penetrations. Snaplock longitudinal are not allowed. Pressure sensitive tape shall not be used as the primary sealant.

↑ All joints and longitudinal seams. Pressure sensitive tape shall not be used as the primary sealant.

→ Transverse joints only.

1 Ducts within the conditioned space to which they supply air or from which they exhaust air need not be sealed.

Longitudinal seams are joints orientated in the direction of air flow. Transverse joints are connections of two duct sections orientated perpendicular to airflow. Duct wall penetrations are openings made by any screw or fastener. Spiral lock joints in round and flat oval duct need not be sealed. All other connections are considered joints including but not limited to spin-ins, lateral taps and other branch connections, access door frames and jambs, duct connections to equipment, etc.

Unless otherwise shown in design documents, ductwork between the supply fan and variable air volume boxes shall be considered to be in the ≥2 in. w.g. pressure classification, while all other ductwork of any application shall be considered 1 in. w.g. pressure classification.

6. SERVICE WATER HEATING

6.1 General. New service water heating systems and equipment shall meet the requirements of this section. The requirements do not apply to water heater replacements.

6.2 Requirements

6.2.1 Service Hot Water Piping Insulation. Pipes up to 1.5 inch (nominal size) shall have 0.50 inches of insulation, pipes between 1.5 and 3.0 inches (nominal size) shall have 0.75 inch of insulation, and pipes larger than 4 inches (nominal size) shall have 1.00 inches of insulation, when used in the following applications.

(a) circulating system piping, including the supply and return piping of a circulating tank type water heater,

(b) the first eight feet of outlet piping for a constant temperature noncirculating storage system,

(c) the inlet pipe between the storage tank and a heat trap in a noncirculating storage system, and

(d) pipes that are externally heated (such as heat trace or impedance heating).

6.2.2 Service Water Heating System Controls

6.2.2.1 Temperature controls must be provided that allow for storage temperature adjustment from 120°F to a temperature compatible with the intended use. Exception: Where the manufacturer's installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion.

6.2.2.2 Circulating System Controls. Automatic time switches or other controls shall be provided that can switch off the systems designed to maintain temperatures in hot water pipes, such as circulating hot water systems or heat trace.

6.2.2.3 Outlet Temperature Controls. For lavatories of public facility restrooms that have hot water, temperature controls shall be provided to limit the temperature of water to 110°F.

6.2.2.4 Circulating Pump Controls. When used to maintain storage tank water temperature, circulating pumps shall be equipped with controls limiting operation to the duration of the heating cycle.

6.2.3 Water Conservation. Shower heads and lavatories shall be labeled as meeting the requirements of the National Energy Policy Act of 1992 (PL 102-486). Lavatories in public facility restrooms shall: (a) be equipped with a foot switch, occupancy sensor, or similar shutoff device or, (b) limit hot water delivery to 0.25 gal/cycle for circulating systems and 0.50 gal/cycle for noncirculating systems. Execption: lavatories for physically handicapped persons.

6.2.4 Gas-Fired Water Heaters. Gas-fired storage water heaters installed in conditioned spaces shall be equipped with a vent damper listed in accordance with nationally recognized safety standards for vent dampers for use on gas appliances.

Exceptions: (a) water heaters equipped with fan assisted combustion or a power venting device and (b) water heaters equipped with a flue damper.

6.2.5 Heat Traps. Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a noncirculating system shall have heat traps on both the inlet and outlet piping as close as practical to the storage tank.

6.2.6 Solar Water Heaters. Piping stubouts shall be provided for water heaters installed in low-rise residential buildings to enable the future installation of solar collectors.

7. LIGHTING

7.1 General

Lighting systems and equipment shall comply with § 7.2, § 7.3 and § 7.4. The lighting requirements in this section shall apply to: (a) interior spaces of buildings; (b) exterior building features, including facades, illuminated roofs, architectural features, entrances, exits, loading docks, and illuminated canopies; and, (c) exterior building grounds lighting that is provided through the building's electrical service.

Exceptions to § 7.1

a) emergency lighting that is automatically off during normal building operation and is powered by battery, generator, or other alternate power source; and,

b) residential dwelling units.

7.2 Mandatory Provisions

7.2.1 Lighting Control

7.2.1.1 Automatic Lighting Shutoff. Interior lighting systems serving more than 5,000 ft^2 shall be equipped with an automatic control device. This automatic control device shall function on either a scheduled basis at specific programmed times or on an unscheduled basis by occupant intervention. An independent program schedule shall be provided for areas of no more than 25,000 ft^2 but not more than one floor.

Exception: lighting systems designed for 24-hour use.

7.2.1.2 Space Control. Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each control device shall be activated either manually by an occupant or automatically by sensing an occupant. Each control device shall

(a) control a maximum of 2,500 ft^2, area for a space less than 10,000 ft^2 and a maximum of 10,000 ft^2 for a space greater than 10,000 ft^2.

(b) be capable of overriding the shutoff control required in 7.2.1.1 for no more than 2 hours, and

(c) be readily accessible and located so the occupant can see the controlled lighting.

Exception to § 7.2.1.2 (c). The required control device may be remotely installed if required for reasons of safety or security. A remotely located device shall have a pilot light indicator as part of or next to the control device and is clearly labeled to identify the controlled lighting.

7.2.1.3 Daylighted Area Control. Luminaires in daylighted areas greater than 250 ft^2 shall be equipped with an independent control device that: (a) is capable of reducing the light output of the luminaires in the daylighted areas by at least 50%, and (b) controls only the luminaires located entirely within the daylighted area.

7.2.1.4 Exterior Lighting Control. Lighting for all exterior applications not exempted shall be controlled by a photosensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.

7.2.1.5 Additional Control. The following lighting applications shall be equipped with a control device to control such lighting independently of general lighting:

(a) Display/Accent Lighting. Display or accent lighting within a 3000 ft^2 area shall have a separate control device.

(b) Case Lighting. Lighting in cases used for display purposes within a 3000 ft^2 area shall be equipped with a separate control device.

(c) Hotel and Motel Guest Room Lighting. Hotel and motel guest rooms and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.

(d) Task Lighting. supplemental task lighting including permanently installed undershelf or undercabinet lighting shall have a control device integral to the luminaire or be controlled by a wall-mounted control device provided the control device complies with 7.2.1.2(c).

(e) Nonvisual Lighting. Lighting for nonvisual applications, such as plant growth and food-warming, shall be equipped with a separate control device.

(f) Demonstration Lighting. Lighting equipment that is for sale or for demonstrations in lighting education shall be equipped with a separate control device accessible only to authorized personnel.

7.2.2 Tandem Wiring. Luminaires designed for use with one or three fluorescent lamps greater than 30 W each shall be tandem-wired whenever such luminaires are in the same space and on the same control device.

Exceptions to § 7.2.2.

(a) recessed luminaires more than 10 ft apart measured center to center

(b) luminaires with three-lamp ballasts

(c) surface mounted or pendant luminaires which are not continuous

(d) luminaires that use electronic ballasts

(e) luminaires on emergency circuits

(f) luminaires with no available pair

7.2.3 Exit Signs. Exit sign luminaires operating at greater than 20 watts shall have a minimum source efficacy of 35 lm/W.

7.2.4 Installed Interior Lighting Power. The installed interior lighting power shall include the power of all the lighting indicated on the plans and specifications. The installed interior lighting power includes all power used by the luminaires, including lamps, ballasts, current regulators, and control devices except as specifically exempted in §7.1.

Exception to § 7.2.4. If two or more independently operating lighting systems in a space are controlled to prevent simultaneous user operation, the installed interior lighting power shall be based solely on the lighting system with the highest power.

7.2.5 Luminaire Wattage. Luminaire wattage incorporated into the installed interior lighting power shall be determined in accordance with the following criteria:

(a) The wattage of incandescent luminaires with medium screw base sockets and not containing permanently installed ballasts shall be the maximum labeled wattage of the luminaire.

(b) The wattage of luminaires containing permanently installed ballasts shall be the operating input wattage of the specified lamp/ballast combination based on values from manufacturers catalogs or values from independent testing laboratory reports.

(c) The wattage of all other miscellaneous luminaire types not described in (a) or (b) shall be the specified wattage of the luminaire.

(d) The wattage of lighting track, plug-in busway, and flexible-lighting systems that allow the addition and/or relocation of luminaires without altering the wiring of the system shall be the larger of the specified wattage of the luminaires included in the system or 45 W/lin ft. Systems with integral over-load protection, such as fuses or circuit breakers, shall be rated at 100% of the maximum rated load of the limiting device.

7.2.6 Exterior Building Grounds Lighting. Lighting for exterior building grounds luminaires which operate at greater than 100 W shall contain lamps having a minimum efficacy of 60 lm/W unless the luminaire is controlled by a motion sensor or exempt under § 7.1.

7.3 Interior Lighting Power

The installed interior lighting power for a building or a separately metered or permitted portion of a building shall be calculated in accordance with § 7.2.5 and shall not exceed the interior lighting power allowance determined in accordance with either § 7.3.1 or § 7.3.2. Tradeoffs of interior lighting power allowance among portions of the building for which a different method of calculation has been used are not permitted.

Exceptions to § 7.3.1: The following lighting equipment and applications shall not be considered when determining the interior lighting power allowance, nor shall the wattage for such lighting be included in the installed interior lighting power identified in accordance with § 7.2.5. However, any such lighting shall not be exempt unless it is an addition to general lighting and is controlled by an independent control device.

(a) Display or accent lighting that is an essential element for the function performed in galleries, museums, and monuments.

(b) Lighting that is integral to equipment or instrumentation and is installed by its manufacturer.

(c) Lighting specifically designed for medical or dental procedures and lighting integral to medical equipment.

(d) Lighting integral to food warming and food preparation equipment.

(e) Lighting for plant growth or maintenance.

(f) Lighting in spaces specifically designed for use by the visually impaired.

(g) Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions.

(h) Lighting in interior spaces that have been specifically designated as a registered interior historic landmark.

(i) Lighting that is an integral part of advertising or directional signage.

(j) Exit signs

(k) Lighting that is for sale or lighting educational demonstration systems.

(l) Lighting for theatrical purposes, including performance, stage, and film or video production.

(m) Athletic playing areas with permanent facilities for television broadcasting.

(n) Casino gaming areas.

7.3.1 Building Area Method Determination of interior lighting power allowance (watts) by the building area method shall be in accordance with the following:

(a) Determine the appropriate building type from Table 7.3.1 and the allowed lighting power density.

(b) Determine the gross lighted floor area of the building.

(c) The interior lighting power allowance is the product of the lighted floor area of the building times the allowed lighting power density.

Table 7.3.1 - Interior Lighting Power - Building Area Method

UBC Group (1994)	Lighting Category	Allowed Lighting Power Density (W/ft^2)
A Assembly	Convention Center	1.3
	Court House	1.3
	Dining/Restaurant	1.5
	Gymnasium	1.3
	Motion Picture Theater	1.0
	Performing Arts Theater	1.5
	Religious Building	2.0
	Sports Arena	1.4
B Business	Automotive Facility	1.0
	Convention Center	1.3
	Dining/Restaurant	1.5
	Educational, Library	1.4
	Exercise Center	1.3
	Hospital/Healthcare	1.7
	Museum	1.1
	Police/Fire Station	1.2
	Post Office	1.5
	Office	1.4
	Retail	2.3
E Educational		1.4
F Factory & Industrial		1.0
I Institutional	Hospital/Healthcare	1.7
	Penitentiary	1.1
M Retail/Mercantile		2.3
R Lodging		1.1
S Storage	Parking Garage	1.0
	Warehouse	1.0

7.3.2 Space Function Method The interior lighting power may alternatively be calculated using the Systems Performance method of ASHRAE/IESNA Standard 90.1-1989.

7.4

7.4 Exterior Building Lighting Power

For building exterior lighting applications specified in Table 7.4, the connected lighting power shall not exceed the specified lighting power limits specified for each of these applications. Trade-offs between applications are not permitted. Exterior lighting for all other applications (except those included in the Exceptions to § 7.4 shall comply with the requirements of § 7.2.6.

Table 7.4

Applications	Power Limits
Building entrance (with canopy)	3 W/ft2 of canopied area
Building entrance (without canopy)	30 W/lin ft of door width
Building exit	20 W/lin ft of door width
Building facades	0.25 W/ft2 of vertical facade area

Exceptions to § 7.4: Lighting used for the following exterior applications is exempt when equipped with an independent control device:

(a) specialized signal, directional, and marker lighting associated with transportation;

(b) lighting used to highlight features of public monuments and registered historic landmark structures or buildings;

(c) lighting that is integral to advertising signage;

(d) lighting that is specifically designated as required by a health or life safety statute, ordinance, or regulation.

8. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

8.1 General

Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this code. These definitions are applicable to all sections of this code. Terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used. Webster's Third New International Dictionary of the English Language, Unabridged, copyright 1986, shall be considered as providing ordinarily accepted meanings.

8.2 Definitions

Add definitions for enclosed buildings, conditioned spaces, and unconditioned spaces.

addition: an extension or increase in floor area or height of a building or to any building system or equipment.

albedo, high: a property of a surface that describes its ability to reflect and reject heat. High albedo surfaces have both a light color (high solar reflectance) and a high emmittance (can reject heat back to the environment).

alteration: any change, rearrangement, replacement, or addition to a building or its systems and equipment; any modification in construction or building equipment.

area: see roof and wall

astronomical time switch: an automatic time switch that makes an adjustment for the length of the day as it varies over the year.

attic and all other roofs: see roof.

building: any structure used or intended for supporting or sheltering any use or occupancy. (see also enclosed building)

building category: the classification of buildings by usage as follows:

(a) assembly: a building or structure for the gathering together of persons such as auditoriums, places of worship, dance halls, clubs, courthouses, gymnasiums, theaters, museums, passenger depots, transportation stations, sports facilities, and public assembly halls.

(b) health and institutional: a building or structure for the purpose of providing medical treatment and research, confinement or care, and sleeping facilities such as hospitals, sanitariums, clinics, orphanages, nursing homes, mental institutions, reformatories, jails, and prisons.

(c) lodging: a building or structure for transient occupancy such as resorts, hotels, motels, barracks, or dormitories.

(d) office (business): a building or structure for office, professional, or service type transactions such as banks and governmental buildings.

(e) food service (restaurant): a building or structure for the consumption of food or drink such as fast-food services, coffee shops, leisure dining, cafeterias, bars, and restaurants.

(f) retail (mercantile): a building or structure for the display and sale (wholesale or retail) of merchandise such as shopping malls, food markets, auto dealerships, department stores, and specialty shops.

(g) school (educational): a building or structure for the purpose of instruction such as schools, colleges, universities, libraries, and academies.

(h) warehouse (storage): a building or structure for storage such as aircraft hangers, garages, warehouses, storage buildings, and freight depots.

building entrance: any doorway, set of doors, turnstiles, or other form of portal that is ordinarily used to

gain access to the building by its users and occupants.

building exit: any doorway, set of doors, or other form of portal that is ordinarily used only for emergency egress or convenience exit.

circulating system: a closed hydronic system consisting of a heating source, means of pumping, distribution piping, load devices (such as radiators), and an expansion chamber.

class of construction: for the building envelope, a subcategory of roof or wall construction.

daylighted area: the area under horizontal fenestration (skylight) or adjacent to vertical fenestration (window) described as follows.

(a) horizontal fenestration area: the area under a skylight with a horizontal dimension in each direction equal to the skylight dimension in that direction plus either the floor-to-ceiling height, the distance to the nearest 42 in. (1070 mm) or higher opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least.

(b) vertical fenestration area: the area adjacent to a window with one horizontal dimension that extends into the space either a distance of 15 ft (4.57 m) or to the nearest 42 in. (1070 mm) or higher opaque partition, whichever is less; and another horizontal dimension equal to the width of the window plus either 2 ft (610 mm) on each side, the distance to an opaque partition, or one-half the distance to an adjacent skylight or window, whichever is least.

dwelling unit: any building or portion thereof which contains living facilities, including provisions for sleeping, eating, cooking and sanitation for not more than one family, or a congregate residence for 10 or fewer persons.

efficacy: the lumens produced by a lamp/ballast combination (the product of rated lamp lumen output and the relative light output of the lamp/ballast combination) divided by the watts of input power, expressed in lumens per watt.

enclosed building: a building that is totally enclosed by walls, roofs, floors, windows, skylights, and/or doors.

facade area, vertical: area of the facade, including non-horizontal roof area, overhangs, and cornices, measured in elevation in a vertical plane parallel to the plane of the face of the building.

fenestration: all areas (including the frames) in the building envelope that let in natural light, including windows, clerestories, skylights, sliding or swinging glass doors that are more than one-half glass, and glass block walls.

(a) skylight: a fenestration surface having a slope of less than 60° from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.

(b) vertical fenestration: all fenestration other than skylights.

fenestration area: total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.

guest room: any room or rooms used or intended to be used by a guest for sleeping purposes.

heat capacity (HC): the amount of heat necessary to raise the temperature of a given mass 1°F. Numerically, the mass expressed per unit of wall surface multiplied by the specific heat [Btu/ft^2-°F].

heat trace: a heating system where the externally applied heat source follows (traces) the object to be heated; e.g., water piping.

infiltration: the uncontrolled inward air leakage through cracks and crevices in any building element and around windows and doors of a building caused by pressure differences across these elements due to factors such as wind, inside and outside temperature differences (stack effect), and imbalance between supply and exhaust air systems.

lamp lumens, rated: the light output of a lamp as published in manufacturer's literature.

lamp wattage, rated: the power consumption of a lamp as published in manufacturer's literature.

lighting efficacy (LE): the quotient of the total lumens emitted from a lamp or lamp/ballast combination divided by the watts of input power, expressed in lumens per watt.

lighting, general: lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

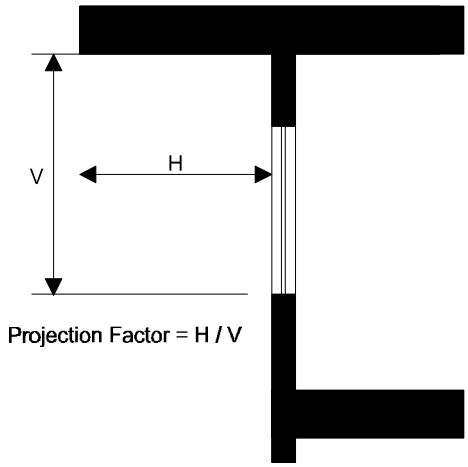
luminaire: a complete lighting unit consisting of a lamp or lamps together with the housing designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.

nonresidential: all occupancies other than residential. (See residential.)

occupant sensor: a device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be regulated accordingly.

optimum start controls: controls that automatically adjust the start time of an HVAC system each day to bring the space to comfort temperature levels immediately before the scheduled hour of occupancy.

projection factor: the ratio of the horizontal depth of the external shading projection divided by the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection, in consistent units.



reflectance: the ratio of the light reflected by a surface to the light incident upon it.

residential: spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, and hostels.

roof: the upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal. For the purposes of determining building envelope requirements, the classifications are defined as follows:

(a) attic and other roofs: all other roofs, including roofs with insulation entirely below (inside of) the roof structure (i.e., attics, cathedral ceilings, and single-rafter ceilings), roofs with insulation both above and below the roof structure, and roofs without insulation, but excluding metal building roofs.

(b) metal building roof: a roof (1) that is not in the roof with insulation entirely above deck category and (2) whose structure consists simply of metal spanning members supported by metal structural members (i.e., does not include composite concrete and metal deck construction.)

(c) mass roof: a roof with a heat capacity exceeding 7.5 or a weight greater than 40 lb/ft^2. Concrete roofs equal to or greater than four inches are considered mass roofs.

roof area, gross: the area of the roof measured from the exterior faces of walls or from the centerline of

walls separating buildings.

shading coefficient: the ratio of solar heat gain at normal incidence through glazing to that occurring through 1/8 in. (3 mm) thick clear, double-strength glass. Shading coefficient, as used herein, does not include interior, exterior, or integral shading devices.

solar heat gain coefficient (SHGC): the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space. (See fenestration area.)

tandem wiring: pairs of luminaires operating with lamps in each luminaire powered from a single ballast contained in one of the luminaires.

thermal resistance (R-value): the mean temperature difference between two defined surfaces of material or construction that induces unit heat flow through a unit area under steady-state conditions. Units of R are h-ft2-°F/Btu.

thermostat: an automatic control device used to maintain temperature at a fixed or adjustable set point.

tinted: (as applied to fenestration) bronze, green, or grey coloring that is integral with the glazing material. Tinting does not include surface applied films such as reflective coatings, applied either in the field or during the manufacturing process.

U-factor (thermal transmittance): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Units of U are Btu/h-ft^2-°F.

wall: that portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between floor spandrels, peripheral edges of floors, and foundation walls. For the purposes of determining building envelope requirements, the classifications are defined as follows:

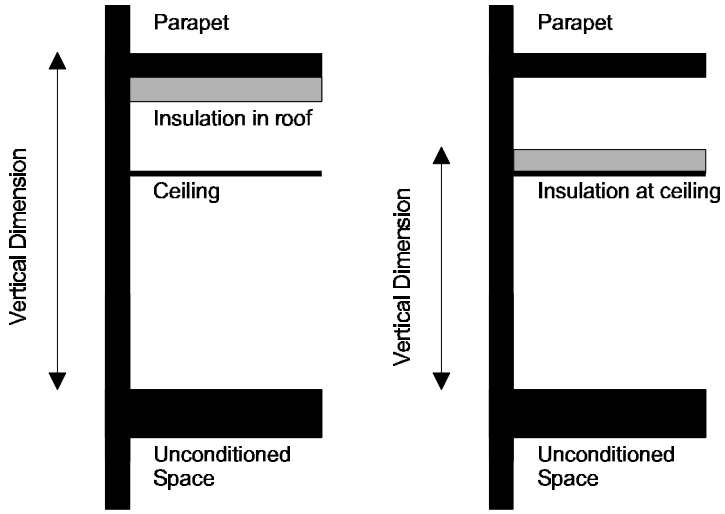
(a) mass wall: a wall with a heat capacity exceeding (1) 7.5 Btu/ft^2-°F or a weight exceeding 35 lb/ft^2.

(b) metal building wall: a wall whose structure consists of simply metal spanning members supported by metal structural members (i.e., does not include spandrel glass or metal panels in curtain wall systems).

(c) metal framing wall: a wall with a cavity (insulated or otherwise) whose exterior surfaces are separated by metal framing members (i.e., typical metal stud walls and curtain wall systems).

(d) wood framing and other walls: all other wall types, including wood stud walls.

wall, gross area: the overall area off a wall including openings such as windows and doors, measured horizontally from outside surface to outside service and measured vertically from the top of the floor to the top of the roof. If roof insulation is installed at the ceiling level rather than the roof, then the vertical measurement is made to the top of the ceiling. The gross wall area includes the area between the ceiling and the floor for multi-story buildings.



wall, heat capacity: the sum of the products of the mass of each individual material in the wall per unit area of wall surface times its individual specific heat [Btu/ft^2-°F].

8.3 Abbreviations and Acronyms

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
Btu	British thermal unit
Btu/h	British thermal unit per hour
Btu/ft^2-°F	British thermal unit per square foot per degree Fahrenheit
Btu/h-ft^2	British thermal unit per hour per square foot
Btu/h-ft-°F	British thermal unit per lineal foot per degree Fahrenheit
Btu/h-ft^2-°F	British thermal unit per hour per square foot per degree Fahrenheit
cfm	cubic feet per minute
DOE	U.S. Department of Energy
EER	energy efficiency ratio
EF	energy factor
F	Fahrenheit
ft	foot
h	hour
HC	heat capacity
Hz	hertz
h×ft^2-°F/Btu	hour per square foot per degree Fahrenheit per British thermal unit
IESNA	Illuminating Engineering Society of North America
in	inch
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
lb	pound
LE	lighting efficacy

lin	linear
lin ft	linear foot
lm	lumen
LPD	lighting power density
NFRC	National Fenestration Rating Council
PF	projection factor
psig	pounds per square inch gauge
R	R-value (thermal resistance)
SHGC	solar heat gain coefficient
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
Tvis	visible light transmission
UL	Underwriters Laboratories Inc.
UV	ultraviolet
VAV	variable air volume
W	watt
W/ft^2	watts per square foot
Wh	watthour