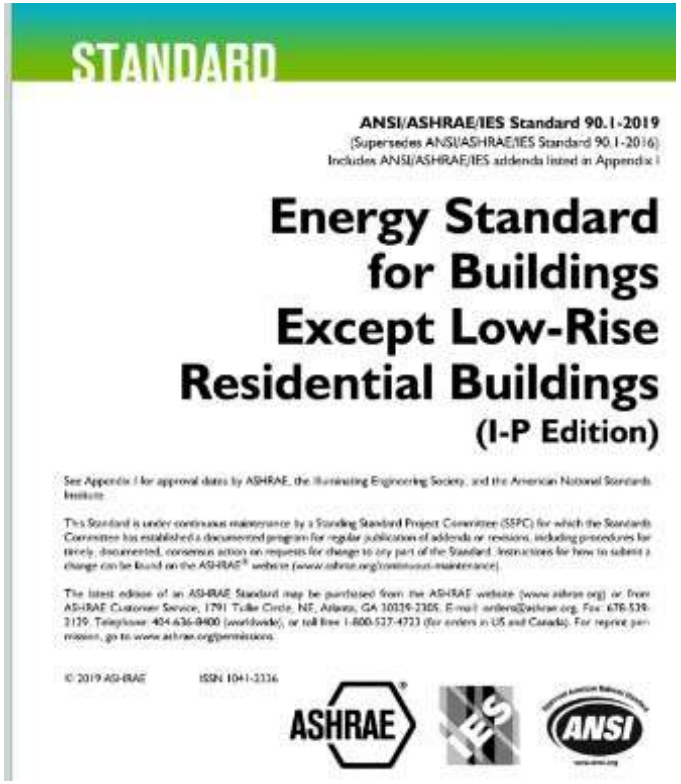
ASHRAE 90.1- 2019


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2019
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2016)
Includes ANSI/ASHRAE/IES addenda listed in Appendix I

Energy Standard for Buildings Except Low-Rise Residential Buildings
(I-P Edition)

See Appendix I for approval dates by ASHRAE, the Illuminating Engineering Society, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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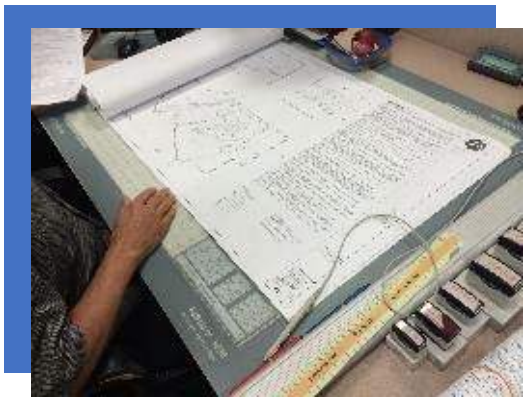
ASHRAE IES ANSI



ASHRAE 90.1- 2019

1

1

Instructor

Gil Rossmiller

- In the construction industry for over 40 years
- ICC – IRC Plumbing & Mechanical Code Development Committee
- ICC – Commercial Energy Code Development Committee
- ICC – Residential Energy Code Development Committee
- 2003-2016 Building Official
  Parker, Colorado

 2

2

Chapters

 3

3

Informative appendix

- This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI. 4

4

Normative appendix

- This is a normative appendix and is part of this standard

5

5

Purpose

- To establish the minimum energy efficiency requirements of buildings other than low-rise residential buildings for:
- a. design, construction, and a plan for operation and maintenance; and
- b. utilization of on-site, renewable energy resources.

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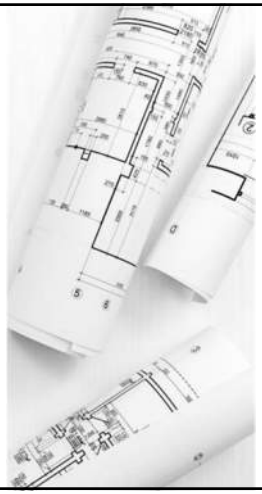

Scope 2.1

- This standard provides
- a. minimum *energy*-efficient requirements for the design and *construction*, and a plan for operation and maintenance of
- 1. new *buildings* and their *systems*,
- 2. new portions of *buildings* and their *systems*,
- 3. new *systems* and *equipment* in *existing buildings*, and
- 4. new *equipment* or *building systems* specifically identified in the standard that are part of industrial or manufacturing processes and
- b. criteria for determining compliance with these requirements.

 7

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Scope 2.2

- The provisions of this standard do not apply to
- a. single-family houses, multifamily structures of three stories or fewer above *grade*, manufactured houses (mobile homes), and manufactured houses (modular) or
- b. *buildings* that use neither electricity nor *fossil fuel*.

 8

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Scope 2.3

- Where specifically noted in this standard, certain other *buildings* or elements of *buildings* shall be exempt.

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Scope 2.4

- This standard shall not be used to circumvent any safety, health, or environmental requirements.

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Definitions

- ***alteration:*** a replacement or addition to a *building* or its *systems* and *equipment*; routine maintenance, *repair*, and *service*, or a change in the *building*'s use classification or category shall not constitute an *alteration*.

 11

11

Definitions

- ***building entrance:*** any doorway, set of *doors*, revolving *door*, vestibule, or other form of portal that is ordinarily used to gain access to the *building* or to exit from the *building* by its users and occupants. This does not include *doors* solely used to directly enter mechanical, electrical, and other *building* utility *service equipment* rooms.

 12

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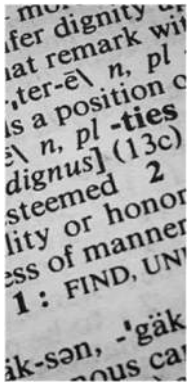
Definitions

- ***building envelope:*** the exterior plus the semiexterior portions of a *building*. For the purposes of determining *building envelope* requirements, the classifications are defined as follows:
- ***exterior building envelope:*** the elements of a *building* that separate *conditioned spaces* from the exterior.
- ***semiexterior building envelope:*** the elements of a *building* that separate *conditioned space* from *unconditioned space* or that enclose *semiheated spaces* through which thermal *energy* may be transferred to or from the exterior, to or from *unconditioned spaces*, or to or from *conditioned spaces*.



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Definitions

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

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Definitions

- **computer room:** a room whose primary function is to house equipment for the processing
- and storage of electronic data and that has a design electronic data equipment power density
- exceeding 20 W/ft2 of conditioned floor area.

 15

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Definitions

- **continuous insulation (c.i.):** insulation that is uncompressed and continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

 16

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Definitions

- **secondary sidelighted area:** the total secondary sidelighted area is the combined secondary sidelighted area within a space. Each secondary sidelighted area is directly adjacent to a primary sidelighted area (see Figure 3.2-4):

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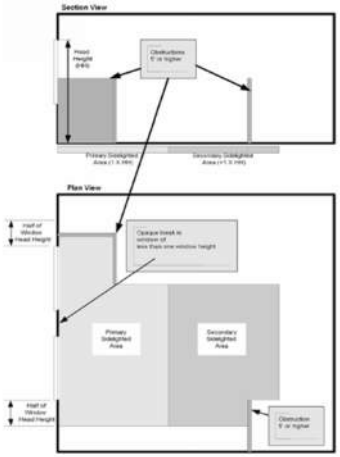

Figure 3.2-4 Computing the secondary sidelighted area.

18

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Definitions

- ***direct digital control (DDC):*** a type of *control* where controlled and monitored analog or binary data (e.g., temperature, contact closures) are converted to digital format for manipulation and calculations by a digital computer or microprocessor and then converted back to analog or binary form to *control* physical devices.

 19

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Definitions

- **enclosed space:** a volume substantially surrounded by solid surfaces, such as walls, floors, roofs, and openable devices, such as doors and operable windows

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Definitions

- **eye adaptation:** the process by which the retina becomes accustomed to more or less light than it was exposed to during an immediately preceding period. It results in a change in the sensitivity to light.

 21

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Definitions

- **fuel:** a material that may be used to produce heat or generate power by combustion.
- **fossil fuel:** fuel derived from a hydrocarbon deposit, such as petroleum, coal, or natural gas derived from living matter of a previous geologic time.

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Definitions

historic: a building or space that has been specifically designated historically significant by the adopting authority or is listed in The National Register of Historic Places or has been determined to be eligible for such listing by the U.S. Secretary of the Interior.

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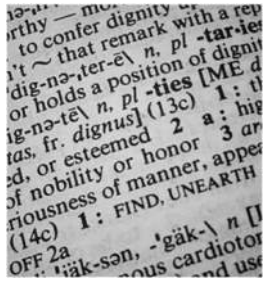
Definitions



- **low-rise residential buildings:** single-family houses, multifamily structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular)

 24

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Definitions

- ***process energy:*** *energy* consumed in support of a manufacturing, industrial, or commercial process other than conditioning *spaces* and maintaining comfort and amenities for the occupants of a *building*.
- ***process load:*** the load on a *building* resulting from the consumption or release of *process energy*.

 25

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Definitions

- ***regulated energy use:*** *energy* used by *building systems* and components with requirements prescribed in Sections 5 through 10. This includes *energy* used for HVAC, lighting, *service water heating*, motors, *transformers*, vertical transportation, refrigeration *equipment*, *computer-room* cooling *equipment*, and other *building systems*, components, and processes with requirements prescribed in Sections 5 through 10

 26

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Definitions space:

- ***conditioned space:*** a *cooled space*, *heated space*, or *indirectly conditioned space* defined as follows:
- a. ***cooled space:*** an *enclosed space* within a *building* that is cooled by a cooling *system* whose sensible output capacity is ≥ 3.4 Btu/h·ft2 of *floor* area.
- b. ***heated space:*** an *enclosed space* within a *building* that is heated by a heating *system* whose output capacity relative to the *floor* area is greater than or equal to the criteria in Table 3.2.

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Definitions space:

- ***semiheated space:*** an *enclosed space* within a *building* that is heated by a heating *system* whose output capacity is greater than or equal to 3.4 Btu/h·ft2 of *floor* area but is not a *conditioned space*.
- ***unconditioned space:*** an *enclosed space* within a *building* that is not a *conditioned space* or a *semiheated space.* Crawlspaces, attics, and parking garages with natural or mechanical *ventilation* are not considered *enclosed spaces*.

 28

28

Table 3.2 *Heated Space* Criteria

Climate Zone	Heating Output, Btu/h·ft^2
0	>5
1	>5
2	>5
3A, 3B	>9
3C	>7
4A, 4B	>10
4C	>8
5	>12
6	>14
7	>16
8	>19

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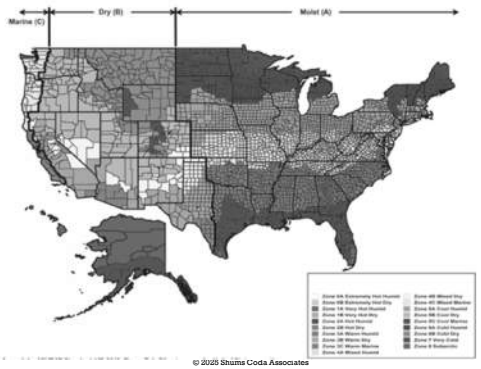
Climate zones



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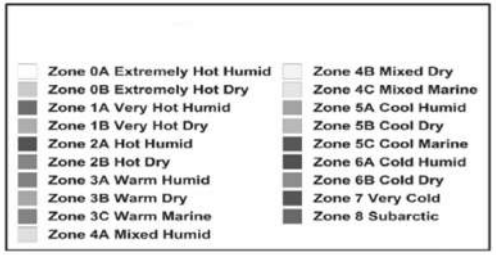
Climate zones



 31

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4.2.1 Compliance Paths New buildings

- Section 5 Building Envelope and
- Section 6 Heating, Ventilating, and Air Conditioning
- and
- Section 7 Service Water Heating
- and
- Section 8 Power
- and
- Section 9 Lighting
- and
- Section 10 Other Equipment
- OR

 32

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4.2.1 Compliance Paths New buildings

- Section 11 *Energy Cost Budget* Method
- OR

 33

33

4.2.1 Compliance Paths New buildings

- Normative Appendix G Performance Rating Method

 34

34

4.2.1.2 Additions to Existing Buildings

- Additions to existing buildings shall comply with either the provisions of Sections 5, 6, 7, 8, 9, and 10, or Section 11 or Normative Appendix G.
- **4.2.1.2.1**
- When an addition to an existing building cannot comply by itself, trade-offs will be allowed by modification to one or more of the existing components of the existing building. Modeling of the modified components of the existing building and addition shall employ the procedures of Section 11 or Normative Appendix G; the addition shall not increase the energy consumption of the existing building plus the addition beyond the energy that would be consumed by the existing building plus the addition if the addition alone did comply.

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4.2.1.3 Alterations of Existing Buildings

- Alterations of existing buildings shall comply with the provisions of Sections 5, 6, 7, 8, 9, and 10, or Section 11 or Normative Appendix G.
- **Exception to 4.2.1.3**
- A building that has been specifically designated as historically significant by the adopting authority or is listed in The National Register of Historic Places or has been determined to be eligible for listing by the U.S. Secretary of the Interior need not comply with these requirements.

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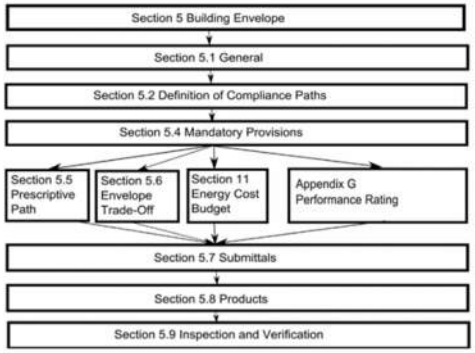

 37

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WHERE DID YOU GET THIS INFORMATION?


COMcheck Software Version COMcheckWeb

Inspection Checklist

Energy Code: 90.1 (2019) Standard

 38

38

THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1

INSPECTORS

- Continuous Air Barrier 5.4.3.1

 39

39

CONTINUOUS AIR BARRIER: the combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope.

 40

40

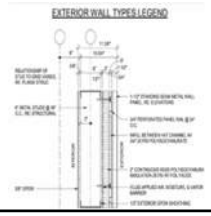
5.4.3.1 Continuous Air Barrier

The exterior building envelope and the semiexterior building envelope shall have a continuous air barrier complying with Sections 5.4.3.1.1 and 5.4.3.1.2.

Exceptions to 5.4.3.1

1. Semiheated spaces in Climate Zones 0 through 6, except as required to complete the continuous air barrier of an adjacent conditioned space.

2. Single wythe concrete masonry buildings in Climate Zone 2B.



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5.4.3.1.1 Whole-Building Air Leakage

Whole-building pressurization testing shall be conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.40 cfm/ft2 under a pressure differential of 0.3 in. of water, with this air leakage rate normalized by the sum of the above-grade and below-grade building envelope areas of the conditioned space and semiheated space.

Where a building contains both conditioned space and semiheated space, compliance shall be shown

a. separately for the conditioned space and for the semiheated space, with the air leak-age rate for the conditioned space normalized by the exterior building envelope area of the conditioned space and the air leakage rate for the semiheated space normalized by the semiexterior building envelope area of the semiheated space; or

b. for the conditioned space and for the semiheated space together, with the air leakage rate for the overall space normalized by the sum of the exterior building envelope area and the semiexterior building envelope area minus the semiexterior building envelope area that separates the conditioned space from the semiheated space.

Reporting shall be in compliance with Section 4.2.5.1.2.

 42

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Exceptions to 5.4.3.1.1

1. For buildings having over 50,000 ft2 of gross conditioned floor area, air leakage testing shall be permitted to be conducted on less than the whole building, provided the following portions of the building are tested and their measured air leakage is area-weighted by the surface areas of the building envelope:
   a. The entire floor area of all stories that have any spaces directly under a roof.
   b. The entire floor area of all stories that have a building entrance or loading dock.
   c. Representative above-grade wall sections of the building totaling at least 25% of the wall area enclosing the remaining conditioned space. Floor area tested per (a) and (b) shall not be included in the 25%.

2. Where the measured air leakage rate exceeds 0.40 cfm/ft2 but does not exceed 0.60 cfm/ft2, a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the building is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of existing building components. In addition, a visual inspection of the air barrier shall be conducted, and any leaks noted shall be sealed if such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner and shall be deemed to satisfy the requirements of this section.

3. Continuous air barrier design and installation verification program in accordance with Section 5.9.1.2.

 43

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5.9.1.2 Verification of the Design and Installation of the Continuous Air Barrier

Verification of the design and installation of the continuous air barrier shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1:

a. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2.

b. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3.

c. Reporting shall comply with Section 4.2.5.1.2.

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5.4.3.1.2 Continuous Air Barrier Design and Installation

The continuous air barrier shall be designed and installed in the following manner:

a. Components designed to provide the continuous air barrier, and the component's position within each of the building envelope assemblies, shall be clearly identified on construction documents.

b. The joints, interconnections, and penetrations of the continuous air barrier components shall be detailed in the construction documents.

c. The continuous air barrier shall extend over all surfaces of the building envelope and be identified in the construction documents to be continuous.

d. The continuous air barrier shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation and allow for anticipated movements.

e. The following areas of the continuous air barrier in the building envelope shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize air leakage:

1. Joints around fenestration and door frames
2. Junctions between walls and floors, between walls at building corners, and between walls and roofs
3. Penetrations through the continuous air barrier in building envelope roofs, walls, and floors
4. Building assemblies used as ducts or plenums
5. Joints, seams, connections between planes, and other changes in continuous air barrier materials

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Table 5.8.3.1 Maximum Air Leakage for Materials and Assemblies

Continuous Air Barrier	Maximum Air Leakage, cfm/ft²	Minimum Test Pressure, psf	Test Method
Materials [a]	0.004	1.57	ASTM E2178
Assemblies [b]	0.04	1.57	ASTM E2357, ASTM E1677, ASTM E1680, ASTM E283

a. The following materials comply with the requirements in Table 5.8.3.1:

1. Plywood—minimum 3/8 in.
2. Oriented strand board—minimum 3/8 in.
3. Extruded polystyrene insulation board—minimum 1/2 in.
4. Foil-faced polyisocyanurate insulation board—minimum 1/2 in.
5. Exterior gypsum sheathing or interior gypsum board—minimum 1/2 in.
6. Cement board—minimum 1/2 in.
7. Built-up roofing membrane
8. Modified bituminous roof membrane
9. Single-ply roof membrane
10. A Portland cement/sand parge, stucco, or gypsum plaster—minimum 1/2 in. thick
11. Cast-in-place and precast concrete
12. Sheet metal
13. Closed-cell 2 lb/ft3 nominal density spray polyurethane foam—minimum 1 in.

b. The following assemblies comply with the requirements in Table 5.8.3.1:

1. Concrete masonry walls that are
(a) fully grouted or
(b) painted to fill the pores
2. Shale or clay masonry units that are assembled as a solid wall: without weeps, with nominal width of 4 in. or more, and with Type S mortar

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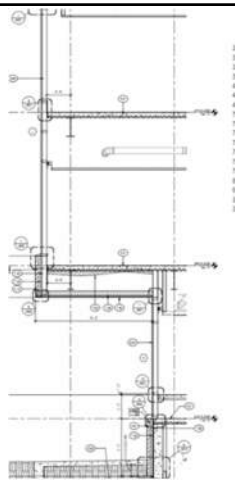

KEYNOTE LEGEND

3.01	CONCRETE FLOOR SLAB
3.02	CONCRETE FOUNDATION
3.02	CONCRETE COUNTERFORT
3.04	CONCRETE PIER
4.01	FACE BRICK, (TYPE AS INDICATED)
4.13	MASONRY CONTROL JOINT
4.81	BRICK LEDGE
7.09	RIGID INSULATION, (THICKNESS AS INDICATED) (R-VALUE AS INDICATED) (TYPE AS INDICATED)
7.14A	METAL WALL PANEL, TYPE MTL-2
7.15	TPO MEMBRANE ROOFING
7.53	METAL PANEL SOFFIT
7.53	SPRAY FOAM INSULATION
7.55	DRAINAGE MAT
7.59	BELOW GRADE MONOLITHIC WATERPROOFING
8.50	ALUMINUM FRAMED CURTAIN WALL
9.06	EXTERIOR GYPSUM SHEATHING
32.08	PERFORATED DRAIN PIPE
32.09	DRAINAGE FILL 6" MINIMUM AROUND FOUNDATION DRAIN

SECTION 07 2726
FLUID APPLIED AIR BARRIERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Air barriers and accessories necessary to complete installation.
   1. Spray Applied Liquid Air Barrier, where indicated on drawings.

B. Materials and installation to bridge and seal the following air leakage pathways and gaps:
   1. Connections of the walls to the roof air barrier
   2. Connections of the walls to the foundations
   3. Expansion joints
   4. Openings and penetrations of window frames, door frames, store front, curtain wall
   5. Door frames Piping, conduit, duct and similar penetrations
   6. Masonry ties, screws, bolts and similar penetrations
   7. All other air leakage pathways through the walls

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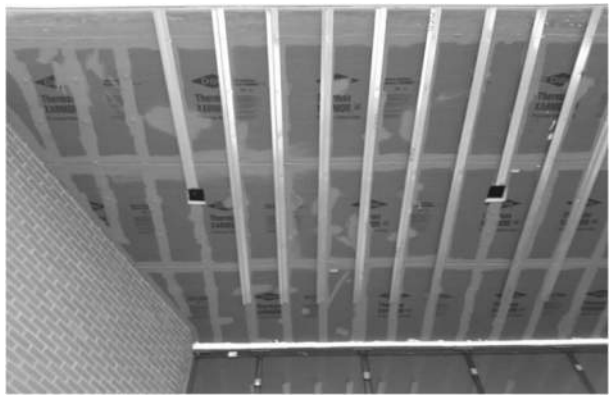

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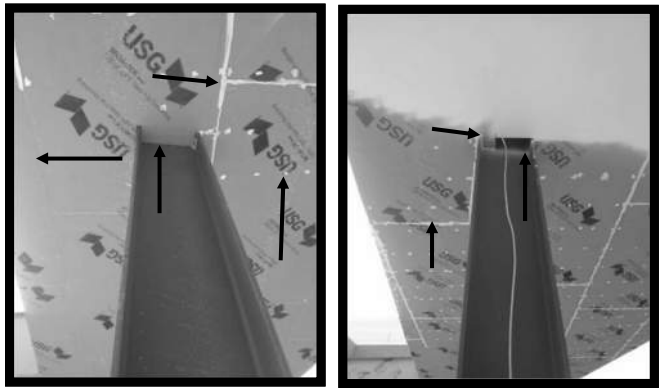

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2

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- **5.4.3.2 Loading Dock Weatherseals**
- In Climate Zones 0 and 4 through 8, cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.

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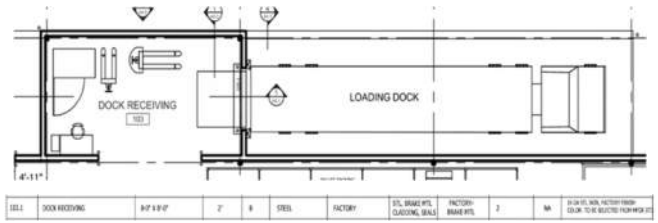

GROUP 2:

OVERHEAD SECTIONAL DOCK DOOR
HARDWARE AND ELECTRIC OPERATOR BY DOOR COMPANY

SEALS: BRUSH SEALS AT HEAD AND JAMB BY DOOR COMPANY

DOOR PANELS: 16 GAUGE GALVANIZED STEEL PANEL FACE; 26 GA BACK COVER; IMPACT-RESISTANT PANEL FACE AT INTERIOR FACE OF BOTTOM 2 FOOT PANEL; R-VALUE 7.35 EXPANDED POLYSTYRENE.

DOOR SPRING: 75K HIGH-CYCLE TORSION SPRINGS

ELECTRIC OPERATOR WITH INTERIOR CONTROLS: OPEN, CLOSE, STOP; EMERGENCY SENSOR STOPS AT OPENING

BASIS OF DESIGN: OVERHEAD DOOR COMPANY; MODLE 418

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2

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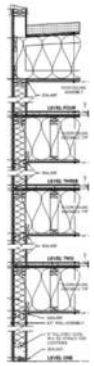
THERMAL ENVELOPE– PLANS EXAMINERS



Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
4.2.2, 5.4.3.1.1, 5.7 [PR1][1]	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	A-101, A-402 ←

4.2.2 Compliance Documentation

4.2.2.1 Construction Details
Compliance documents shall show all the pertinent data and features of the building, equipment, and systems in sufficient detail to permit a determination of compliance by the building official and to indicate compliance with the requirements of this standard.

4.2.2.2 Supplemental Information
Supplemental information necessary to verify compliance with this standard, such as calculations, worksheets, compliance forms, vendor literature, or other data, shall be made avail-able when required by the building official.

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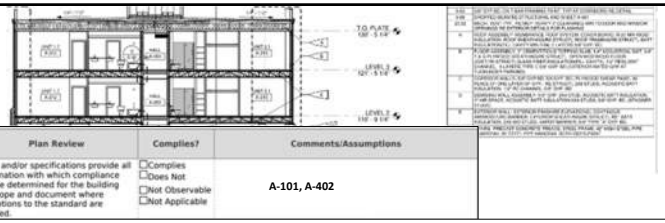

Section # & Req.ID	Plan Review	Complies?	Comments/Assumptions
4.2.2, 5.4.3.1.1, 5.7 [PR1][1]	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed.	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	A-101, A-402

5.7.2 Permit Application Documentation
Application documents shall include, at a minimum, the type and rated R-value of insulation for each product; opaque door schedule showing the U-factor for each opaque door product as determined in accordance with Section 5.8.2; fenestration schedule showing the manufacturer, model number, orientation, area, U-factor, SHGC, and VT for each fenestration product, as determined in accordance with Section 5.8.2; and air leakage details in accordance with Section 5.4.3. In addition:
a. Labeling of space conditioning categories. For buildings that contain spaces that will be only semiheated space or unconditioned space, and compliance is sought using the semiheated space building envelope criteria, such spaces shall be clearly indicated on the floor plans.
b. Labeling of daylight areas. Daylighting documentation shall identify daylight areas on floor plans, including the primary sidelighted areas, secondary sidelighted areas, daylight area under skylights, and daylight area under roof monitor.

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THERMAL ENVELOPE– PLANS EXAMINERS

Table 3 Inspection Checklist for Proposed Design - Envelope

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN	SHEET LOCATION	CONFIRMED
Above-grade Walls	Type: Wood framed R-20 or R-13 + R-5 continuous Gross area: Same as proposed U-factor: 0.060 Solar absorptance: 0.75 Emittance: 0.90	Type: Wood framed R-21 insulation Gross area: 133,167 SF U-factor: 0.059 Solar absorptance: 0.75 Emittance: 0.90	A4-10	
Basement and Crawl Space Walls	Type: NA Gross Area: NA U-factor: NA	Type: NA Gross Area: NA U-factor: NA	N/A	N/A
Above-grade floors	Type: wood framed R-30 (or enough to fill framing cavity) Gross area: Same as proposed U-factor: 0.033	Type: wood framed with fiber insulation filling cavity Gross area: 218,523 U-factor: NO.033	A0-40	
Ceilings	Type: wood frame R-49 Gross Area: Same as proposed U-factor: 0.026	Type: wood frame R-49 Gross Area: Same as proposed U-factor: 0.026	A4-10	
Roofs	Type: composition shingle on wood sheathing Gross area: Same as proposed Solar absorptance: 0.75 Emittance: 0.90	Type: composition shingle on wood sheathing Gross area: 72,841 SF Solar absorptance: 0.75 Emittance: 0.90	A4-10	
Attics	Type: vented with aperature = 1 ft² per 300 ft² ceiling area	Type: Non vented	A0-40	
Foundations	Type: Same as proposed Foundation wall area above and below grade and soil characteristics: same as proposed	Slab on grade Vapor barrier, no foundation insulation	A4-10	
Opaque doors	Area: Same as proposed Orientation: Same as proposed U-factor: 0.377	Area: 5,750 SF Orientation: all orientations of building A, B, C U-factor: 0.37	A7-10	
Vertical fenestration other than opaque doors	Area: Same as proposed North: Same as proposed East: Same as proposed South: Same as proposed West: Same as proposed Building Average: Same as proposed U-factor: 0.32 SHGC 0.40	Area: 21,932 North: 19% East: 13% South: 20% West: 13% Building Average: 16.5% U-factor: Solarban 60: U-0.32 SHGC: Solarban 60: SHGC 0.40	A2-A30, A2-B30, A2-B31, A2-C30, A2-C31 A4-10	
Skylights	External shading: N/A Area: N/A	External shading: N/A Area: N/A	N/A N/A	N/A N/A

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Table 5.5-5 *Building Envelope* Requirements for Climate Zone 5 (A,B,C)[a]

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. *R*-Value	Assembly Maximum	Insulation Min. *R*-Value	Assembly Maximum	Insulation Min. *R*-Value
Roofs						
Insulation entirely above deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal building[d]	U-0.037	R-19 + R-11 *Lx* or R-25 + R-8 *Lx*	U-0.037	R-19 + R-11 *Lx* or R-25 + R-8 *Lx*	U-0.082	R-19
Attic and other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above grade						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[b]	R-5.7 c.i.[b]
Metal building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-9.8 c.i.
Steel-framed	U-0.055	R-13 + R-10 c.i.	U-0.055	R-13 + R-10 c.i.	U-0.084	R-13+R-3.8 c.i.
Wood-framed and other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.089	R-13
Wall, below Grade						
Below-grade wall	C-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
Floors						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
Steel joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
Wood-framed and other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
Slab-on-Grade Floors						
Unheated	F-0.520	R-15 for 24 in	F-0.510	R-20 for 24 in.	F-0.730	NR
Heated	F-0.688	R-20 for 48 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U-0.370		U-0.370		U-0.370	
Nonswinging	U-0.310		U-0.310		U-0.360	

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation

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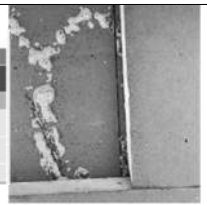
5.5.3.1 Roof Insulation
All roofs shall comply with the insulation values specified in Tables 5.5-0 through 5.5-8.
Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5.0, whichever is less.

Table 5.5-5 *Building Envelope* Requirements for Climate Zone 5 (A,B,C)[a]

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. *R*-Value	Assembly Maximum	Insulation Min. *R*-Value	Assembly Maximum	Insulation Min. *R*-Value
Roofs						
Insulation entirely above deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal building[d]	U-0.037	R-19 + R-11 *Lx* or R-25 + R-8 *Lx*	U-0.037	R-19 + R-11 *Lx* or R-25 + R-8 *Lx*	U-0.082	R-19
Attic and other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30



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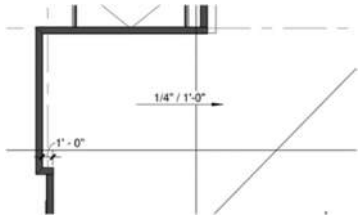
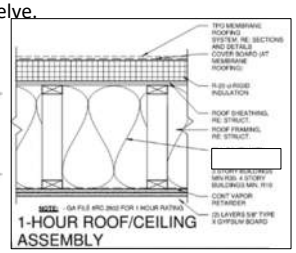
ROOF INSULATION – PLANS EXAMINERS

5.8.1.3 Loose-Fill Insulation Limitation
Open-blown or poured loose-fill insulation shall not be used in attic roof spaces when the slope of the ceiling is more than three in twelve.





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- **5.8.1.2 Manufacturer's Installation Instructions**
- Insulation materials shall be installed in accordance with manufacturers' recommendations and in such a manner as to achieve the rated R-value of insulation.
- **Exceptions to 5.8.1.2**
- The R-value of compressed cavity insulation is determined in accordance with Table A9.4.3.
- 2. Where metal building roof or wall insulation is compressed between the steel structure and the metal roof or wall panels, the overall assembly U-factor is determined in accordance with Section A2.3, Section A3.2, or Section A9.4.5.

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ROOF INSULATION - INSPECTORS

4.2.4 Inspections
All building construction, additions, or alterations work subject to the provisions of this standard shall remain accessible and exposed for inspection purposes until approved in accordance with the procedures specified by the building official.

1 High Impact (Tier 1)	2 Medium Impact (Tier 2)	3 Low Impact (Tier 3)

Section # & Req.ID	Insulation Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments/Assumptions
4.2.4 [IN2][1]	Installed roof insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports. For some ceiling systems, verification may need to occur during Framing Inspection.	R-____ ☐ Above deck ☐ Metal ☐ Attic	R-____ ☐ Above deck ☐ Metal ☐ Attic	☐Complies ☐Does Not ☐Not Observable ☐Not Applicable	*See the Envelope Assemblies table for values.*

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation 5.8.1.4

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation 5.8.1.2 & 4.2.4
- Above Grade Wall Insulation 5.8.1.2 & 4.2.4

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Table 3.3-5 Building Envelope Requirements for Climate Zone 5 (A,B,C)

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation entirely above deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal building[a]	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
Attic and other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above grade						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[b]	R-8.7 c.i.[b]
Metal building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-8.8 c.i.
Steel-framed	U-0.055	R-13 + R-10 c.i.	U-0.055	R-13 + R-10 c.i.	U-0.084	R-13+R-3.8 c.i.
Wood-framed and other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.089	R-13

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5.8.1.2 Manufacturer's Installation Instructions

Insulation materials shall be installed in accordance with manufacturers' recommendations and in such a manner as to achieve the rated R-value of insulation.

Exceptions to 5.8.1.2

1. The R-value of compressed cavity insulation is determined in accordance with Table A9.4.3.

2. Where metal building roof or wall insulation is compressed between the steel structure and the metal roof or wall panels, the overall assembly U-factor is determined in accordance with Section A2.3, Section A3.2, or Section A9.4.5.

4.2.4 [IN6][1]	Installed above-grade wall insulation type and R-value consistent with insulation specifications reported in plans and COMcheck reports.
5.8.1.2 [IN7][1]	Above-grade wall insulation installed per manufacturer's instructions.

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation 5.8.1.4

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation 5.8.1.2 & 4.2.4
- Above Grade Wall Insulation 5.8.1.2 & 4.2.4
- Insulation Protection 5.8.1.7

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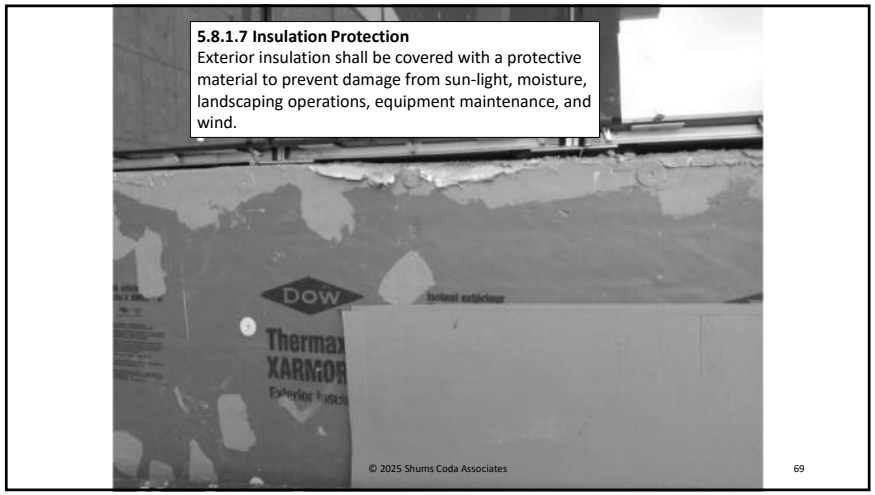

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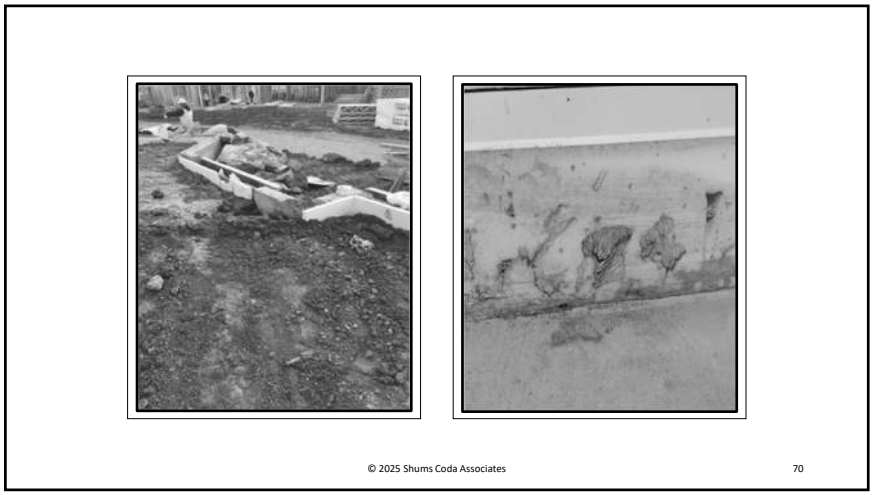

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation 5.8.1.4
- Insulation In Ground Contact 5.8.1.7.3

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation 5.8.1.2 & 4.2.4
- Above Grade Wall Insulation 5.8.1.2 & 4.2.4
- Insulation Protection 5.8.1.7
- Insulation in Ground Contact 5.8.1.7.3

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5.8.1.7.3
Insulation materials in ground contact shall have a water absorption rate no greater than 0.3% when tested in accordance with ASTM C272.

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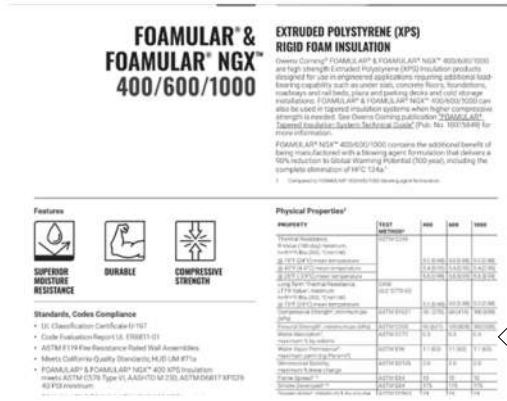
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COMPRESSIVE STRENGTH

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PLANS EXAMINERS

5.8.1.7.3 Insulation materials in ground contact shall have a water absorption rate no greater than 0.3% when tested in accordance with ASTM C272.

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INSPECTORS

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation 5.8.1.4
- Insulation In Ground Contact 5.8.1.7.3
- Vertical Glazing U-Factor & SHGC 5.5.4.3 & 5.5.4.4.1

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation 5.8.1.2 & 4.2.4
- Above Grade Wall Insulation 5.8.1.2 & 4.2.4
- Insulation Protection 5.8.1.7
- Insulation in Ground Contact 5.8.1.7.3
- Vertical Glazing U-Factor & SHGC

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5.5.4.3 Fenestration U-Factor
Fenestration shall have a U-factor not greater than that specified in Tables 5.5-0 through 5.5-8.
Exception to 5.5.4.3
The U-factor for skylights is permitted to be increased to no greater than 0.90 Btuh ft2 in Climate Zones 0 through 3 and 0.75 Btu/h ft2 °F in Climate Zones 4 through 8, provided the sky-lights meet all of the criteria in Exception (1) to Section 5.5.4.4.2.

Table 5.5-5 ***Building Envelope*** **Requirements for Climate Zone 5 (A,B,C)***

	Nonresidential			*Residential*			*Semiheated*		
Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. SHGC	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
Vertical Fenestration, 0% to 40% of Wall									
Fixed	0.36	0.38	1.10 (for all types)	0.36	0.38	1.10 (for all types)	0.50	NR (for all types)	NR (for all types)
Operable	0.45	0.33		0.45	0.33		0.65		
Entrance door	0.63	0.33		0.63	0.33		0.77		
Skylight, 0% to 3% of Roof									
All types	0.50	0.40	NR	0.50	0.40	NR	0.75	NR	NR

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5.5.4.4 Fenestration Solar Heat Gain Coefficient (SHGC)
5.5.4.4.1 SHGC of Vertical Fenestration
Vertical fenestration shall have an SHGC not greater than that specified in Tables 5.5-0 through 5.5-8.

Table 5.5-5 *Building Envelope* Requirements for Climate Zone 5 (A,B,C)*

	Nonresidential			*Residential*			*Semiheated*		
Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. SHGC	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
Vertical Fenestration, 0% to 40% of Wall									
Fixed	0.36	0.38	1.10 (for all types)	0.36	0.38	1.10 (for all types)	0.50	NR (for all types)	NR (for all types)
Operable	0.45	0.33		0.45	0.33		0.65		
Entrance door	0.63	0.33		0.63	0.33		0.77		
Skylight, 0% to 3% of Roof									
All types	0.50	0.40	NR	0.50	0.40	NR	0.75	NR	NR

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Exceptions to Section 5.5.4.4.1

1. For demonstrating compliance for south-, east-, or west-oriented vertical fenestration shaded by opaque permanent projections that will last as long as the building itself, the SHGC of the shaded vertical fenestration in the proposed design is permitted to be reduced by using the multipliers in Table 5.5.4.4.1. Permanent projections consisting of open louvers shall be considered to provide shading, provided that no sun penetrates the louvers during the peak sun angle on June 21.

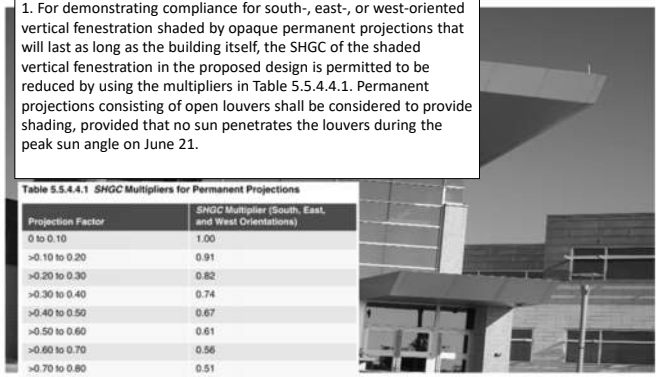

Table 5.5.4.4.1 *SHGC* Multipliers for Permanent Projections

Projection Factor	*SHGC* Multiplier (South, East, and West Orientations)
0 to 0.10	1.00
>0.10 to 0.20	0.91
>0.20 to 0.30	0.82
>0.30 to 0.40	0.74
>0.40 to 0.50	0.67
>0.50 to 0.60	0.61
>0.60 to 0.70	0.56
>0.70 to 0.80	0.51
>0.80 to 0.90	0.47
>0.90 to 1.00	0.44

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2. For demonstrating compliance for south-, east-, or west-oriented vertical fenestration shaded by partially opaque permanent projections (e.g., framing with glass or perforated metal) that will last as long as the building itself, the projection factor (PF) shall be reduced by multiplying it by a factor of Os, which is derived as follows:

$$Os = (Ai \times Oi) + (Af \times Of)$$

where
Os = percent opacity of the shading device
Ai = percent of the area of the shading device that is a partially opaque infill
Oi = percent opacity of the infill for glass Oi = (100% – Ts), where Ts is the solar transmittance as determined in accordance with NFRC 300; for perforated or decorative metal panels, Oi = percentage of solid material
Af = percent of the area of the shading device that represents the framing members
Of = percent opacity of the framing members; if solid then 100%
The SHGC of the shaded vertical fenestration in the proposed building is permitted to then be reduced by using the multipliers in Table 5.5.4.4.1 for each fenestration product.

Table 5.5.4.4.1 *SHGC* Multipliers for Permanent Projections

Projection Factor	*SHGC* Multiplier (South, East, and West Orientations)
0 to 0.10	1.00
>0.10 to 0.20	0.91
>0.20 to 0.30	0.82
>0.30 to 0.40	0.74
>0.40 to 0.50	0.67
>0.50 to 0.60	0.61
>0.60 to 0.70	0.56
>0.70 to 0.80	0.51
>0.80 to 0.90	0.47
>0.90 to 1.00	0.44

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3. Vertical fenestration that is located on the street side of the street-level story only, provided that

a. the street side of the street-level story does not exceed 20 ft in height,

b. the fenestration has a continuous overhang with a weighted average PF greater than 0.5, and

c. the fenestration area for the street side of the street-level story is less than 75% of the gross wall area for the street side of the street-level story.

When this exception is used, separate calculations shall be performed for these sections of the building envelope, and these values shall not be averaged with any others for compliance purposes. No credit shall be given here or elsewhere in the building for not fully utilizing the fenestration area allowed.

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5.5.4.3 Fenestration U-Factor
Fenestration shall have a U-factor not greater than that specified in Tables 5.5-0 through 5.5-8.
Exception to 5.5.4.3
The U-factor for skylights is permitted to be increased to no greater than 0.90 Btu/h·ft2·°F in Climate Zones 0 through 3 and 0.75 Btu/h·ft2·°F in Climate Zones 4 through 8, provided the sky-lights meet all of the criteria in Exception (1) to Section 5.5.4.4.2.
5.5.4.4.2 SHGC of Skylights
Skylights shall have an SHGC not greater than that specified in Tables 5.5-0 through 5.5-8.
Exceptions to Section 5.5.4.4.2
1. Skylights are exempt from SHGC requirements provided the following:
a. They have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003.
b. They have a skylight VT greater than 0.40.
c. They have all general lighting in the daylight area under skylights controlled by multi-level photocontrols in accordance with Section 9.4.1.1(f).
2. For dynamic glazing, the minimum SHGC shall be used to demonstrate compliance with this section. Dynamic glazing shall be considered separately from other skylights, and area-weighted averaging with other skylights that is not dynamic glazing shall not be permitted.

Table 5.5-5 ***Building Envelope*** **Requirements for Climate Zone 5 (A,B,C)***

	Nonresidential			*Residential*			*Semiheated*		
Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. SHGC	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
Skylight, 0% to 3% of Roof									
All types	0.50	0.40	NR	0.50	0.40	NR	0.75	NR	NR

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5.5.4.2.3 Minimum Skylight Fenestration Area

2,500 ft² in floor area directly under a roof with ceiling height > 15 ft.
If you have one of these occupancies:

- office,
- lobby,
- atrium,
- concourse,
- corridor,
- storage area,
- Gymnasium.
- Fitness/exercise area
- Playing area
- Gymnasium seating area,
- automotive service area,
- Convention exhibit/event space,
- courtroom
- manufacturing corridor/transition and bay areas,
- non-refrigerated warehouse,
- retail,
- Library reading and stack areas
- distribution/sorting area,
- transportation baggage and seating areas
- Workshop
- Fire station engine room

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5.5.4.2.3 Minimum Skylight Fenestration Area

Exceptions to Section 5.5.4.2.3

1. Enclosed spaces in Climate Zones 6 through 8.
2. Enclosed spaces where it is documented that existing structures or natural objects block direct-beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.
3. Enclosed spaces where the daylight area under roof monitors is greater than 50% of the enclosed space floor area
4. Enclosed spaces where it is documented that 90% of the skylight area is shaded on June 21 in the Northern Hemisphere (December 21 in the Southern Hemisphere) at noon by permanent architectural features of the building.
5. Enclosed spaces where the total area minus the primary sidelighted area and secondary sidelighted area is less than 2500 ft2 and where the lighting is controlled according to side-lighting requirements described in Section 9.4.1.1(e).

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THERMAL ENVELOPE

PLANS EXAMINERS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Thermal Envelope Information
- Roof Insulation 5.8.1.4
- Insulation In Ground Contact 5.8.1.7.3
- Vertical Glazing U-Factor & SHGC 5.5.4.3 & 5.5.4.4.1
- Labeling of Fenestration and Doors 5.8.2.2

INSPECTORS

- Continuous Air Barrier 5.4.3.1
- Loading Dock Weatherseals 5.4.3.2
- Roof Insulation 5.8.1.2 & 4.2.4
- Above Grade Wall Insulation 5.8.1.2 & 4.2.4
- Insulation Protection 5.8.1.7
- Insulation in Ground Contact 5.8.1.7.3
- Vertical Glazing U-Factor & SHGC
- Labeling of Fenestration and Doors

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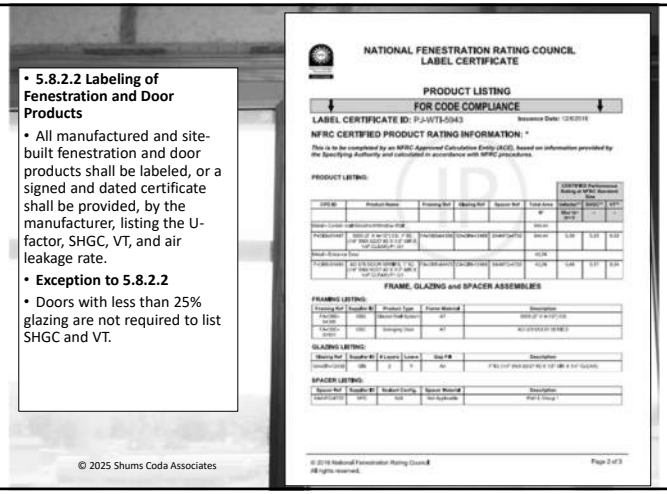

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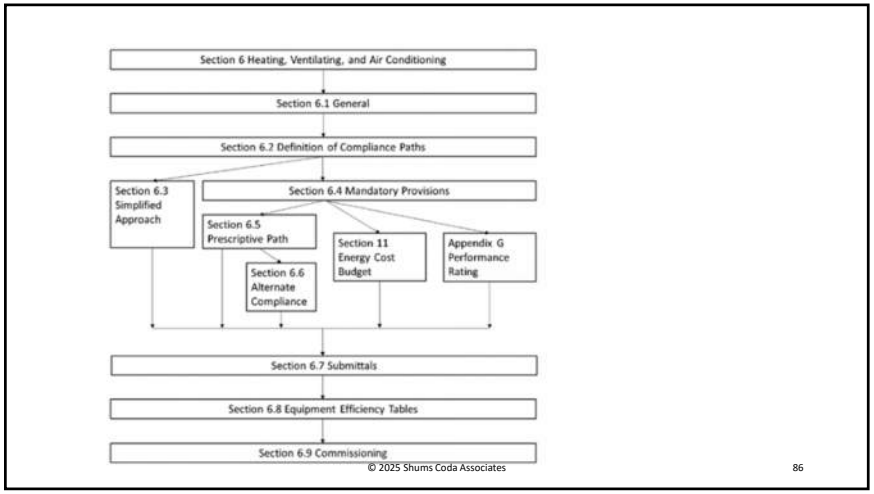

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6 Heating, Ventilating, and Air Conditioning

- **6.1.1.3 Alterations to Heating, Ventilating, Air Conditioning, and Refrigeration in Existing Buildings**
- **6.1.1.3.1**
- New HVACR *equipment* as a direct replacement of existing HVACR *equipment* shall comply with the following sections as applicable for the *equipment* being replaced:

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6 Heating, Ventilating, and Air Conditioning

- **6.1.1.3.1**
- New HVACR *equipment* as a direct replacement of existing HVACR *equipment* shall comply with the following sections as applicable for the *equipment* being replaced:
- a. 6.3, Simplified Approach Option for *HVAC Systems*
- b. 6.4.1, *Equipment* Efficiencies, Verification, and Labeling Requirements
- c. 6.4.3.1, Zone *Thermostatic Controls*
- d. 6.4.3.2, S*et-Point* Overlap Restrictions
- e. 6.4.3.3, Off-Hour *Controls* except for Section 6.4.3.3.4, Zone Isolation
- f. 6.4.3.4, *Ventilation System Controls*
- g. 6.4.3.7, Freeze Protection and Snow/Ice Melting *Systems*
- h. 6.4.3.8, *Ventilation Controls* for High-Occupancy Areas only for single-zone *equipment*

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6 Heating, Ventilating, and Air Conditioning

- **6.1.1.3.1**
- New HVACR *equipment* as a direct replacement of existing HVACR *equipment* shall comply with the following sections as applicable for the *equipment* being replaced:
- i. 6.4.3.9, Heated or Cooled Vestibules
- j. 6.4.5, *Walk-In Coolers* and *Walk-In Freezers*
- k. 6.5.1.1, *Air Economizers* for units located outdoors
- l. 6.5.1.3, Integrated Economizer *Control*
- m. 6.5.1.4, Economizer Heating *System* Impact
- n. 6.5.3.1.3, Fan *Efficiency*
- o. 6.5.3.2.1, Supply Fan Airflow *Control*
- p. 6.5.3.6, Fractional Horsepower Fan Motors
- q. 6.5.4.1, *Boiler* Turndown
- r. 6.5.4.3, Chiller and *Boiler* Isolation
- s. 6.5.5.2, Fan Speed *Control*

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6.2 Compliance Paths

Mechanical equipment and systems providing heating, cooling, ventilating, or refrigeration shall comply with Section 6.2.1 and Section 6.2.2.

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6 Heating, Ventilating, and Air Conditioning

- **6.2.1 Requirements for all Compliance Paths**
- Mechanical equipment and systems shall comply with
- Section 6.4, Mandatory Provisions
- Section 6.7, Submittals;
- Section 6.8, Minimum *Equipment Efficiency* Tables;

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6.2.2 Additional Requirements to Comply with Section 6

Mechanical equipment and systems shall comply with one of the following:

a. Section 6.3, Simplified Approach Building Compliance Path for HVAC Systems

b. Sections 6.5, Prescriptive Compliance Path

6 Heating, Ventilating, and Air Conditioning

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- **Exceptions to 6.2.2(b)**
- HVAC systems serving only the heating, cooling, or ventilating needs of a computer room with IT equipment load greater than 20 kW shall be permitted to comply with Section 6.4, "Mandatory Provisions" and Section 6.6, "Alternative Compliance Path".

6 Heating, Ventilating, and Air Conditioning

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6 Heating, Ventilating, and Air Conditioning

- **6.3 Simplified Approach Building Compliance Path for HVAC Systems**
- The simplified approach is an optional path for compliance when the following conditions are met:
- a. The *building* is two stories or fewer in height.
- b. *Gross floor area* is less than 25,000 ft2.
- c. Each *HVAC system* in the *building* complies with the requirements listed in Section 6.3.2.
- Section 6.3.2 contains another 19 requirements

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6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**
- **6.4.1 Equipment Efficiencies, Verification, and Labeling Requirements**

Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and *Condensing Units*—Minimum *Efficiency* Requirements

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum *Efficiency*	Test Procedure[a]
Air conditioners, air cooled	<65,000 Btu/h[b]	All	Split *system*, three phase	13.0 *SEER*	AHRI 210/240
			Single package, three phase	14 *SEER*	
Through the *wall*, air cooled	≤30,000 Btu/h[b]	All	Split *system*, three phase	12.0 *SEER*	AHRI 210/240
			Single package, three phase	12.0 *SEER*	
Small duct, high velocity, air cooled	<65,000 Btu/h[b]	All	Split *system*, three phase	11.0 *SEER*	AHRI 210/240

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seasonal energy efficiency ratio (SEER): the total cooling output of an air conditioner during its normal annual usage period for cooling divided by the total electric *energy* input during the same period.

energy efficiency ratio (EER): the ratio of net cooling capacity (Btu/h) to total rate of electric input in watts under designated operating conditions.

integrated energy efficiency ratio (IEER): a single-number figure of merit expressing cooling part-load EER efficiency for commercial unitary air conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

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ROOF TOP UNIT SCHEDULE (GAS FIRED HEATING/ DX)

COOLING CAPACITY										HEATING CAPACITY				
TOTAL CAPACITY (MBH)	SENS CAPACITY (MBH)	EAT		LAT		COND °F	# COMP	# STAGE	EER	IEER	CAP @ ALT (MBH)	EAT °F	LAT °F	NG DATA
		DB °F	WB °F	DB °F	WB °F									NG INPUT @ SL (MBH) / NG AFUE %
862	848	81.2	62.0	52.0	51.9	95.0	6.0	6.0	10.1	14.1	449	34.4	55	701 / 80
1051	1022	78.8	61.0	53.0	51.8	95.0	6.0	6.0	10.3	13.4	404	33.5	55	632 / 80
462	459	78.7	62.0	55.2	54.2	95.0	4.0	4.0	10.3	17.1	169	38.0	55	264 / 80
106	83	80.2	62.0	49.4	49.0	95.0	2.0	2.0	12.1	19.8	117	46.1	90	300 / 80

Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and *Condensing Units*—Minimum *Efficiency* Requirements *(Continued)*

Equipment Type	*Size Category*	*Heating Section Type*	*Subcategory or Rating Condition*	*Minimum Efficiency*	*Test Procedure*[a]
Air conditioners, air cooled (continued)	≥240,000 Btu/h and <760,000 Btu/h	*Electric resistance* (or none)	Split *system* and single package	10.0 *EER* 11.6 *IEER* before 1/1/2023 13.2 *IEER* after 1/1/2023	AHRI 340/360
		All other		9.8 *EER* 11.4 *IEER* before 1/1/2023 13.0 *IEER* after 1/1/2023	
	≥760,000 Btu/h	*Electric resistance* (or none)		9.7 *EER* 11.2 *IEER* before 1/1/2023 12.5 *IEER* after 1/1/2023	
		All other		9.5 *EER* 11.0 *IEER* before 1/1/2023 12.3 *IEER* after 1/1/2023	

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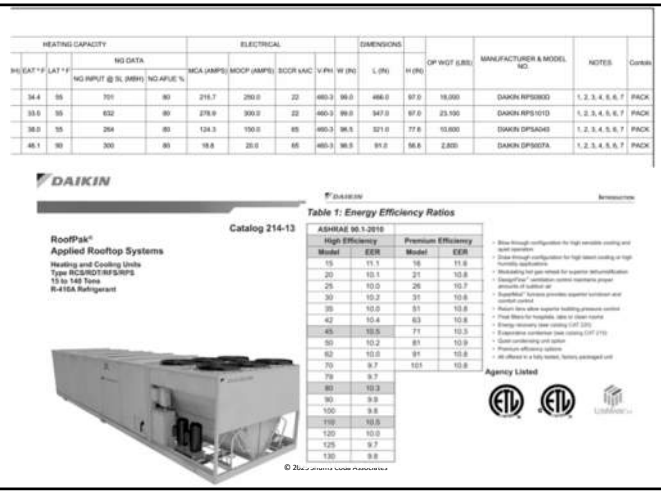

DAIKIN

RoofPak®
Applied Rooftop Systems

Catalog 214-13

Heating and Cooling Units
Type RCS/RDT/RFS/RPS
15 to 140 Tons
R-410A Refrigerant

Table 1: Energy Efficiency Ratios

ASHRAE 90.1-2010			
High Efficiency		Premium Efficiency	
Model	EER	Model	EER
15	11.1	16	11.6
20	10.1	21	10.8
25	10.0	26	10.7
30	10.2	31	10.6
35	10.0	51	10.8
42	10.4	63	10.6
45	10.5	71	10.3
50	10.2	81	10.9
62	10.0	91	10.6
70	9.7	101	10.8
75	9.7		
80	10.3		
90	9.8		
100	9.8		
110	10.5		
120	10.0		
125	9.7		
130	9.8		

Agency Listed

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6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**
- **6.4.1.3 Ceiling Fans**
- Large-diameter ceiling fans shall be rated in accordance with 10 CFR 430 Appendix U or AMCA 230. The following data shall be provided:
  - a. Blade span (blade tip diameter)
  - b. Rated airflow and power consumption at the maximum speed
- **6.4.1.3.1**
- The data provided shall meet one of the following requirements:
  - a. It is determined by an independent laboratory.
  - b. It is included in a database published by USDOE.
  - c. It is certified under a program meeting the requirements of Section 6.4.1.5.

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6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**
- **6.4.2.1 Load Calculations**
- Heating and cooling *system* design loads for the purpose of sizing *systems* and *equipment* shall be determined in accordance with ANSI/ASHRAE/ACCA Standard 183.

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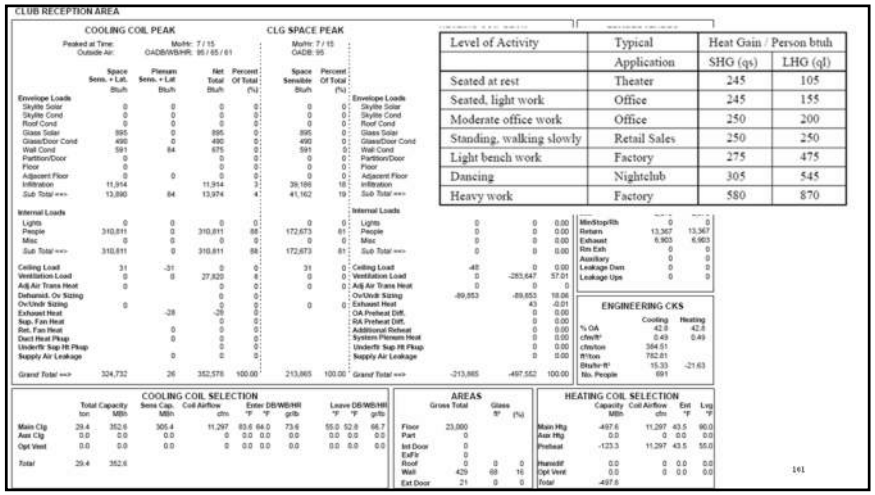
CLUB RECEPTION AREA

COOLING COIL PEAK

CLG SPACE PEAK

Level of Activity	Typical Application	Heat Gain / Person btuh SHG (qs)	LHG (ql)
Seated at rest	Theater	245	105
Seated, light work	Office	245	155
Moderate office work	Office	250	200
Standing, walking slowly	Retail Sales	250	250
Light bench work	Factory	275	475
Dancing	Nightclub	305	545
Heavy work	Factory	580	870

ENGINEERING CKS

COOLING COIL SELECTION

AREAS

HEATING COIL SELECTION

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- **6.4 Mandatory Provisions**
- **6.4.3.3.1 Automatic Shutdown**
- *HVAC systems* shall be equipped with at least one of the following:
- a. *Controls* that can start and stop the *system* under different time schedules for seven different day types per week, are capable of retaining programming and time setting during loss of power for a period of at least ten hours, and include an accessible manual override or equivalent function that allows temporary operation of the *system* for up to two hours.
- b. An *occupant sensor* that is capable of shutting the *system* off when no occupant is sensed for a period of up to 30 minutes.
- c. A manually operated timer capable of being adjusted to operate the *system* for up to two hours.
- d. An interlock to a security *system* that shuts the *system* off when the security *system* is activated.

6 Heating, Ventilating, and Air Conditioning

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6.4 Mandatory Provisions

6.4.3.3.5 Automatic Control of HVAC in Hotel/Motel Guest Rooms

Hotels and motels with greater than 50 guest rooms shall be provided with *automatic controls*

for the HVAC *equipment* serving each guest room capable of and configured according to the requirements in the following subsection.

6 Heating, Ventilating, and Air Conditioning

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6.4 Mandatory Provisions

- **6.4.3.3.5.1 Guest Room HVAC Set-Point Control**
- HVAC systems serving hotel guest rooms shall be capable of and configured with three modes of temperature control.
- **a. Rented and unoccupied.** Within 20 minutes of all occupants leaving the guest room, HVAC set points shall be automatically raised by at least 4°F from the occupant set point in the cooling mode and automatically lowered by at least 4°F from the occupant set point in the heating mode.

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6.4 Mandatory Provisions

- **b. Unrented and unoccupied.** HVAC set points shall be automatically reset to 80°F or higher in the cooling mode and to 60°F or lower in the heating mode. The HVAC setpoints in the unrented and unoccupied guest room modes shall be initiated within 16 hours of the guest room being continuously unoccupied or within 20 minutes of the guest room being continuously unoccupied where a networked guest room control system indicates the guest room is unrented.
- **c. Occupied.** HVAC set points shall return to their occupied set points once occupancy is sensed

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6.4.3.3.5.2 Guest Room Ventilation Control

- Within 20 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall automatically be turned off, or isolation devices serving each guest room shall automatically shut off the supply of outdoor air to the guest room and shut off exhaust air from the guest room.
- **Exception to 6.4.3.3.5.2**
- Guest room ventilation systems shall be permitted to have an automatic daily preoccupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes or at a rate and duration equivalent to one air change.

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6.4.3.3.5 Automatic Control of HVAC in Hotel/Motel Guest Rooms

- **6.4.3.3.5.3 Automatic Control**
- Card key card controls shall be permitted to be used to indicate occupancy.

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6.4.3.4 Ventilation System Controls

- **6.4.3.4.1 Stair and Shaft Vents**
- Stair and elevator shaft vents shall be equipped with motorized dampers that are capable of and configured to automatically close during normal building operation and are interlocked to open as required by fire and smoke detection systems

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6.4.3.4 Ventilation System Controls

- **6.4.3.4.2 Shutoff Damper Controls**
- All outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use. Outdoor air and exhaust/relief dampers shall be capable of and configured to automatically shut off during preoccupancy building warm-up, cooldown, and setback, except when the supply of outdoor air reduces energy costs or when outdoor air must be supplied to meet code requirements.

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6.4.3.4.2 Shutoff Damper Controls

- **Exceptions to 6.4.3.4.2**
- 1. Nonmotorized (gravity back draft) dampers are acceptable for exhaust and relief in buildings less than three stories in height and for outdoor air intakes and exhaust and relief dampers in buildings of any height located in Climate Zones 0, 1, 2, and 3. Nonmotorized dampers for outdoor air intakes must be protected from direct exposure to wind.
- 2. Nonmotorized dampers are acceptable in systems with a design outdoor air intake or
- exhaust capacity of 300 cfm or less.
- 3. Dampers are not required in ventilation or exhaust systems serving unconditioned spaces.
- 4. Dampers are not required in exhaust systems serving Type 1 kitchen exhaust hoods.
- 5. Dampers are not required in systems intended to operate continuously.

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6.4.3.4 Ventilation System Controls

Table 6.4.3.4.3 Maximum Damper Leakage[a,b], cfm per ft² at 1.0 in. of water

Climate Zone	Outdoor Air Intake		Exhaust/Relief	
	Nonmotorized[a]	Motorized	Nonmotorized[c]	Motorized
0, 1, 2				
Any height	20	4	20	4
3				
Any height	20	10	20	10
4, 5B, 5C				
Fewer than three stories	20[d]	10	20	10
Three or more stories	20[d]	10	20[d]	10
5A, 6, 7, 8				
Fewer than three stories	20[d]	4	20	4
Three or more stories	20[d]	4	20[d]	4

a. When tested in accordance with AMCA Standard 500-D.
b. Dampers smaller than 12 in. in height, width, or diameter need not be tested but shall be of the same design and construction as the smallest tested damper
meeting the listed leakage rate requirement.
c. Nonmotorized dampers smaller than 24 in. in height, width, or diameter may have a leakage rate of 40 cfm/ft2.
d. Where allowed by Section 6.4.3.4.2, Exception 2.

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Section 6.4.3.4.5 Enclosed Parking Garage Ventilation

Enclosed parking garage ventilation systems shall automatically detect contaminant levels and stage fans or modulate fan airflow rates to 50% or less of design capacity, provided acceptable contaminant levels are maintained.

Exceptions to 6.4.3.4.5

1. Garages less than 30,000 ft with ventilation systems that do not utilize mechanical cooling or mechanical heating.

2. Garages that have a garage area to ventilation system motor nameplate horsepower ratio that exceeds 1500 ft2/hp and do not utilize mechanical cooling.

2. Where not permitted by the authority having jurisdiction

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6.4.3.5 Heat-Pump Auxiliary Heat Control

- Heat pumps equipped with internal electric resistance heaters shall have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery.
- Supplemental heater operation is permitted during outdoor coil defrost cycles

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6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**
- **6.4.3.6 Humidification and Dehumidification**
- Humidity *control* shall prevent the use of *fossil fuel* or electricity to produce relative humidity above 30% in the warmest zone served by the humidification *system* and to reduce relative humidity below 60% in the coldest zone served by the dehumidification *system*.
- Where a zone is served by a *system* or *systems* with both humidification and dehumidification capability, means (such as limit switches, mechanical stops, or, for *DDC systems*, software programming) shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification *equipment*.

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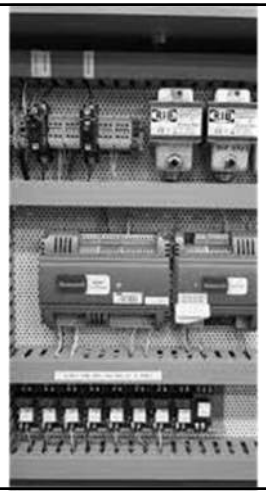
6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**
- **6.4.3.10 Direct Digital Control (DDC) Requirements**
- *Direct digital control* shall be required as follows.
- **6.4.3.10.1 DDC Applications**
- *DDC* shall be provided in the applications and qualifications listed in Table 6.4.3.10.1.



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6 Heating, Ventilating, and Air Conditioning

- **6.4 Mandatory Provisions**

Table 6.4.3.10.1 *DDC* Applications and Qualifications

Building Status	Application	Qualifications
New *building*	Air-handling *system* and all zones served by the *system*	Individual *systems* supplying more than three zones and with fan *system* bhp of 10 hp and larger
	Chilled-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger
	Hot-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger
Alteration or addition	Zone *terminal* unit such as *VAV* box	Where existing zones served by the same air-handling, chilled-water, or hot-water *system* have *DDC*
	Air-handling *system* or fan coil	Where existing air-handling *systems* and fan coils served by the same chilled- or hot-water plant have *DDC*
	New air-handling *system* and all new zones served by the *system*	Individual *systems* with fan *system* bhp of 10 hp and larger and supplying more than three zones and more than 75% of zones are new
	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger
	New or upgraded hot-water plant	Where all *boilers* are new and plant design heating capacity is 300,000 Btu/h and larger

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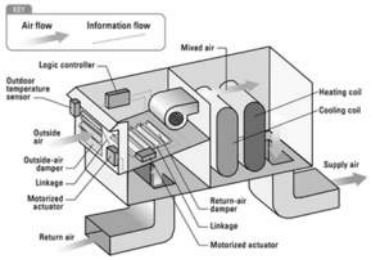
6.4.3.12 Economizer Fault Detection and Diagnostics (FDD)

- Air-cooled direct-expansion cooling units listed in Tables 6.8.1-1 and 6.8.1-2, where an air economizer is installed in accordance with Section 6.5.1, shall include a fault detection and diagnostics (FDD) system complying with the following:



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6.5 Prescriptive Compliance Path

Table 6.5.1-1 Minimum Fan-Cooling Unit Size for which an Economizer Is Required

Climate Zone	Cooling Capacity for which an Economizer Is Required
0A, 0B, 1A, 1B	No economizer requirement
2A, 2B, 3A, 4A, 5A, 6A, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	≥54,000 Btu/h

- 6.5.1 Economizers

Table 6.5.1-2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling *Efficiency*

Climate Zone	*Efficiency* Improvement[a]
2A	17%
2B	21%
3A	27%
3B	32%
3C	65%
4A	42%
4B	49%
4C	64%
5A	49%
5B	59%
5C	74%
6A	56%
6B	65%
7	72%
8	77%

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6.5 Prescriptive Compliance Path

- **6.5.2 Simultaneous Heating and Cooling Limitation**
- **6.5.2.1 Zone Controls**
- Zone thermostatic control shall prevent
- a. reheating;
- b. recooling;
- c. mixing or simultaneously supplying air that has been previously mechanically heated and air that has been previously cooled, either by mechanical cooling or by economizer systems; and
- d. other simultaneous operation of heating and cooling systems to the same zone.

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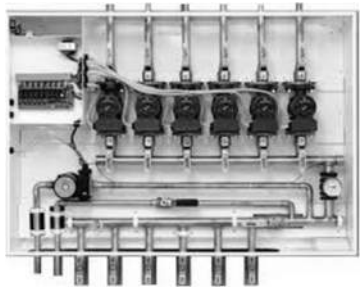
6.5 Prescriptive Compliance Path

- **6.5.2.2 Hydronic System Controls**
- The heating of fluids in hydronic systems that have been previously mechanically cooled, and the cooling of fluids that have been previously mechanically heated, shall be limited in accordance with Sections 6.5.2.2.1 through 6.5.2.2.3.



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6.5 Prescriptive Compliance Path

- **6.5.6 Energy Recovery**

Table 6.5.6.1.2-1 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Less than 8000 Hours per Year

	% *Outdoor Air* at Full Design Airflow Rate							
Climate Zone	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥120
7,8	≥4500	≥4000	≥2500	≥1000	≥140	≥120	≥100	≥80

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6.5 Prescriptive Compliance Path

- **6.5.6 Energy Recovery**

Table 6.5.6.1.2-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

	% *Outdoor Air* at Full Design Airflow Rate							
Climate Zone	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

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6.5 Prescriptive Compliance Path

- **6.5.8 Radiant Heating Systems**
- **6.5.8.1 Heating Unenclosed Spaces**
- Radiant heating shall be used when heating is required for unenclosed spaces.

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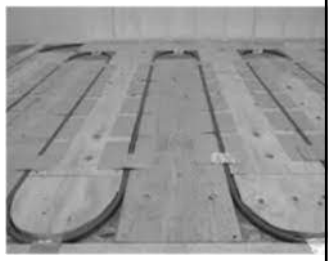
6.5 Prescriptive Compliance Path

- **6.5.8 Radiant Heating Systems**
- **6.5.8.2 Heating Enclosed Spaces**
- Radiant heating systems that are used as primary or supplemental heating for enclosed spaces must be in conformance with the governing provisions of the standard, including but not limited to the following:
- a. Radiant hydronic ceiling or floor panels (used for heating or cooling)
- b. Combination or hybrid systems incorporating radiant heating (or cooling) panels
- c. Radiant heating (or cooling) panels used in conjunction with other systems such as VAV or thermal storage systems



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Section 6.6 Alternate Compliance Path

- **6.6.1 Computer Rooms Systems**
- HVAC systems only serving the heating, cooling, or ventilating needs of a computer room with IT equipment load greater than 10 kW shall comply with ASHRAE Standard 90.4, Energy Standard for Data Centers.

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6 Heating, Ventilating, and Air Conditioning

6.7.2 Completion Requirements

The following requirements are mandatory provisions and are necessary for compliance with the standard.

6.7.2.1 Drawings

Construction documents shall require that, within 90 days after the date of *system* acceptance, *record drawings* of the actual installation be provided to the *building* owner or the designated representative of the *building* owner.

6.7.2.2 Manuals

Construction documents shall require that an operating *manual* and a maintenance *manual* be provided to the *building* owner or the designated representative of the *building* owner within 90 days after the date of *system* acceptance.

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6 Heating, Ventilating, and Air Conditioning

- **6.7.2.4 System Commissioning**
- HVAC *control systems* shall be tested to ensure that *control* elements are calibrated, adjusted, and in proper working condition. For projects larger than 50,000 ft2 conditioned area, except warehouses and *semiheated spaces*, detailed instructions for commissioning *HVAC systems* (see Informative Appendix E) shall be provided by the designer in plans and specifications

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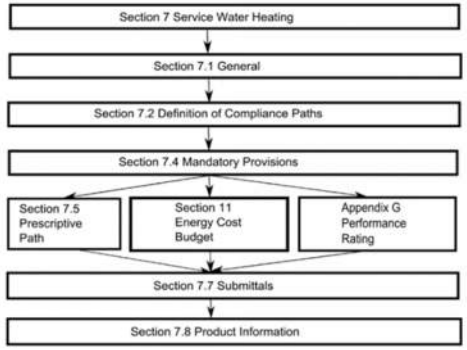

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7 Service Water Heating

- **7.4 Mandatory Provisions**
- **7.4.2 Equipment Efficiency**
- All water-heating *equipment*, *hot-water supply boilers* used solely for heating potable water, *pool* heaters, and hot-water storage tanks shall meet the criteria listed in Table 7.8. Where multiple criteria are listed, all criteria shall be met. Omission of minimum performance requirements for certain classes of *equipment* does not preclude use of such *equipment* where appropriate. *Equipment* not listed in Table 7.8 has no minimum performance requirements.

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7 Service Water Heating

Table 7.8 Performance Requirements for Water-Heating *Equipment*—Minimum *Efficiency* Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required [a]	Test Procedure[b,c]
Electric table-top water heaters	≤12 *kW*	Resistance ≥20 gal	See footnote (g).	
Electric *water heaters*	≤12 *kW*[e]	Resistance ≥20 gal	See footnote (g).	
	>12 *kW*[e]	Resistance ≥20 gal	0.3 + 27/Vm %/h	Section G.2 of ANSI Z21.10.3
	≤24 Amps and ≤250 Volts	Heat pump	See footnote (g).	
Gas storage *water heaters*	≤75,000 Btu/h	≥20 gal	See footnote (g).	
	>75,000 Btu/h[f]	<4000 (Btu/h)/gal	80% E_t (Q/800 + 110.$\sqrt{V}$) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3
Gas instantaneous *water heaters*	>50,000 Btu/h and <200,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	See footnote (g).	
	≥200,000 Btu/h[d,f]	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Sections G.1 and G.2 of ANSI Z21.10.3
	≥200,000 Btu/h[f]	≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110.$\sqrt{V}$) SL, Btu/h	
Oil storage *water heaters*	≤105,000 Btu/h	≥20 gal	See footnote (g).	
	>105,000 Btu/h	<4000 (Btu/h)/gal	80% E_t (Q/800 + 110.$\sqrt{V}$) SL, Btu/h	Sections G.1 and G.2 of ANSI Z21.10.3

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7 Service Water Heating

- **7.4 Mandatory Provisions**

- **7.4.3 Service Hot-Water Piping Insulation**
- The following *piping* shall be insulated to levels shown in Section 6, Table 6.8.3-1:
- a. *Recirculating system piping*, including the supply and return *piping* of a circulating tank type *water heater*.
- b. The first 8 ft of outlet *piping* for a constant-temperature nonrecirculating storage *system*.
- c. The first 8 ft of branch *piping* connecting to recirculated, heat-traced, or impedance heated *piping*.
- d. The inlet *piping* between the storage tank and a heat trap in a nonrecirculating storage *system*.
- e. *Piping* that is externally heated (such as *heat trace* or impedance heating).

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7.4.4 Service Water-Heating System Controls

- 7.4.4.1 Temperature Controls
- Temperature controls shall be provided that allow for storage temperature adjustment from 120°F or lower to a maximum temperature compatible with the intended us

- Exception to 7.4.4.1
- When the manufacturers' installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion.

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7.4.4 Service Water-Heating System Controls

- 7.4.4.2 Temperature Maintenance Controls
- Systems designed to maintain usage temperatures in hot-water pipes, such as recirculating hot-water systems or heat trace, shall be equipped with automatic time switches or other controls that can be set to switch off the usage temperature maintenance system during extended periods when hot water is not required.

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7.4.4 Service Water-Heating System Controls

- 7.4.4.3 Outlet Temperature Controls
- Temperature controlling means shall be provided to limit the maximum temperature of water delivered from lavatory faucets in public facility restrooms to 110°F.

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7.4.4 Service Water-Heating System Controls

- 7.4.4.4 Circulating Pump Controls
- When used to maintain storage tank water temperature, recirculating pumps shall be equipped with controls limiting operation to a period from the start of the heating cycle to a maximum of five minutes after the end of the heating cycle.

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7 Service Water Heating

- **7.4 Mandatory Provisions**
- 7.4.5.1 Pool Heaters
- Pool heaters shall be equipped with a readily accessible on/off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas shall not have continuously burning pilot lights.

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7 Service Water Heating

- **7.4 Mandatory Provisions**
- **7.4.5.2 Pool Covers**
- Heated *pools* shall be equipped with a vapor retardant *pool* cover on or at the water surface.
- *Pools* heated to more than 90°F shall have a *pool* cover with a minimum insulation value of R-12.

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7 Service Water Heating

- **7.4 Mandatory Provisions**
- **7.4.5.3 Time Switches**
- Time switches shall be installed on swimming pool heaters and pump
- **Exceptions to 7.4.5.3**
- 1. Where public health standards require 24-hour pump operation.
- 2. Where pumps are required to operate solar and waste heat recovery pool heating system

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7 Service Water Heating
7.5 Prescriptive Compliance Path

- **7.5.1 Space Heating and Service Water Heating**
- The use of a gas-fired or oil-fired space-heating boiler system otherwise complying with Section 6 to provide the total space heating and service water heating for a building is allowed when one of the following conditions is met:

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7 Service Water Heating
7.5 Prescriptive Compliance Path

- a. The single space-heating boiler, or the component of a modular or multiple boiler system that is heating the service water, has a standby loss in Btu/h not exceeding (13.3 x pmd + 400)/n where pmd is the probable maximum demand in gal/h determined in accordance with the procedures described in generally accepted engineering standards and hand-books, and n is the fraction of the year when the outdoor daily mean temperature is greater than 64.9°F.
- b. The standby loss is to be determined for a test period of 24 hours duration while maintaining a boiler water temperature of at least 90°F above ambient, with an ambient temperature between 60°F and 90°F. For a boiler with a modulating burner, this test shall be conducted at the lowest input.

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7 Service Water Heating
7.5 Prescriptive Compliance Path

- c. It is demonstrated to the satisfaction of the authority having jurisdiction that the use of a single heat source will consume less energy than separate units.
- d. The energy input of the combined boiler and water heater system is less than 150,000 Btu/h.

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7 Service Water Heating
7.5 Prescriptive Compliance Path

- **7.5.2 Service Water-Heating Equipment**
- Service water-heating equipment used to provide the additional function of space heating as part of a combination (integrated) system shall satisfy all stated requirements for the service water-heating equipment.

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7 Service Water Heating
7.5 Prescriptive Compliance Path

- **7.5.3 Buildings with High-Capacity Service Water-Heating Systems**
- New buildings with gas service water-heating systems with a total installed gas water-heating input capacity of 1,000,000 Btu/h or greater, shall have gas service water-heating equipment with a minimum thermal efficiency (Et) of 90%. Multiple units of gas water-heating equipment are allowed to meet this requirement if the water-heating input provided by equipment with thermal efficiency (Et) above and below 90% provides an input capacity-weighted average thermal efficiency of at least 90%.

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7 Service Water Heating
7.5 Prescriptive Compliance Path

Exceptions:

1. Where 25% of the annual service water-heating requirement is provided by site-solar energy or site-recovered energy.
2. Water heaters installed in individual dwelling units.
3. Individual gas water heaters with input capacity not greater than 100,000 Btu/h.

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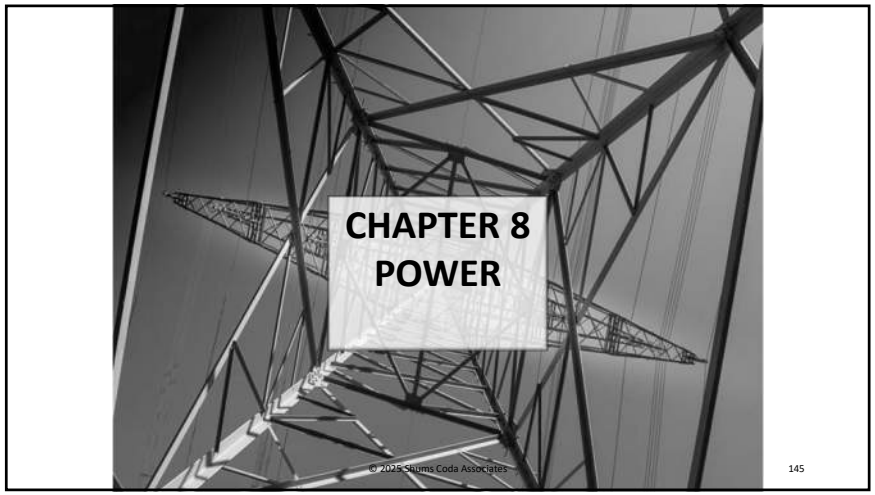

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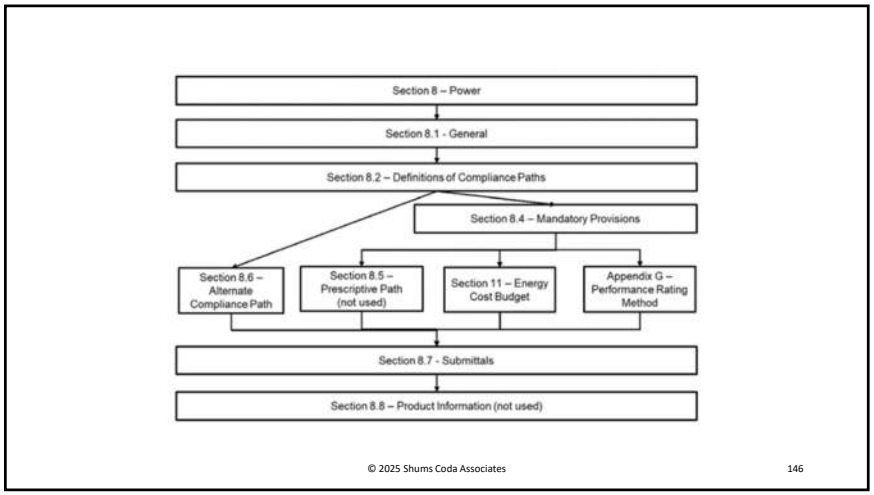

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Power

- **8.1.4 Alterations to Existing Buildings**

- **Exception to 8.1.4**
- Compliance shall not be required for the relocation or reuse of existing equipment at the same site.
- **8.1.4.1**
- Alterations to building service equipment or systems shall comply with the requirements of this section applicable to those specific portions of the building and its systems that are being altered.
- **8.1.4.2**
- Any new equipment subject to the requirements of this section that is installed in conjunction with the alterations as a direct replacement of existing equipment shall comply with the specific requirements applicable to that equipment.

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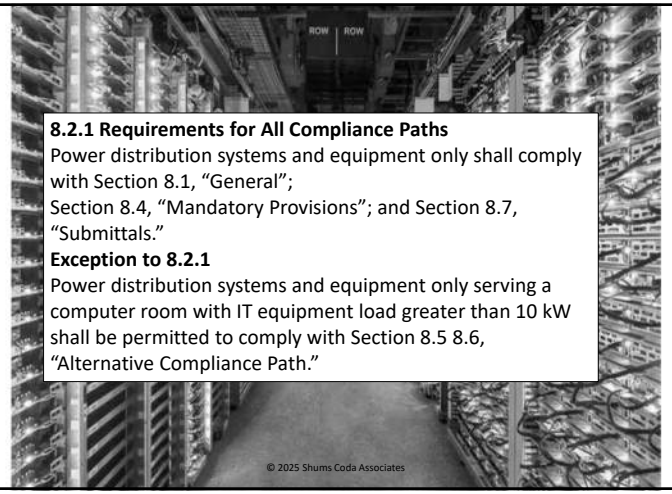

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8.4.2 Automatic Receptacle Control
The following shall be automatically controlled:

a. At least 50% of all 125 V, 15 and 20 amp receptacles in all private offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, classrooms, and individual workstations.
b. At least 25% of branch circuit feeders installed for modular furniture not shown on the construction documents.

This control 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 controlled areas of no more than 5000 ft2 and not more than one floor (the occupant shall be able to manually override the control device for up to two hours);
b. an occupancy sensor that shall turn receptacles off within 20 minutes of all occupants leaving a space; or
c. an automated signal from another control or alarm system that shall turn receptacles off within 20 minutes after determining that the area is unoccupied.
All controlled receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles and are to be uniformly distributed throughout the space.
Plug-in devices shall not be used to comply with Section 8.4.2.

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Power Mandatory

Exceptions to 8.4.2

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

1. Receptacles specifically designated for equipment requiring continuous operation (24/day, 365 days/year).

2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.

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8.4.3 Electrical Energy Monitoring

8.4.3.1Monitoring

- Measurement devices shall be installed in new buildings to monitor the electrical energy use for each of the following separately:
- **a.** Total electrical energy **b.** HVAC systems **c.** Interior lighting **d.** Exterior lighting
- **e.** Receptacle circuits
- For buildings with tenants, these systems shall be separately monitored for the total building and (excluding shared systems) for each individual tenant.
- **Exception to 8.4.3.1**
- Up to 10% of the load for each of the categories (b) through (e) shall be allowed to be from other electrical loads

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Power Mandatory
8.4.3.2 Recording and Reporting

- The electrical energy use for all loads specified in Section 8.4.3.1 shall be recorded a minimum of every 15 minutes and reported at least hourly, daily, monthly, and annually.
- The data for each tenant space shall be made available to that tenant.
- In buildings with a digital control system installed to comply with Section 6.4.3.10, the energy use data shall be transmitted to the digital control system and graphically displayed.
- The system shall be capable of maintaining all data collected for a minimum of 36 months

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Power Mandatory
Exceptions to Sections 8.4.3.1 and 8.4.3.2

- 1.Building less than 25,000 ft2.
- 2.Individual tenant spaces less than 10,000 ft2.
- 3.Dwelling units
- 4.Residential buildings with less than 10,000 ft2of common area.
- 5.Critical and Equipment branches of NEC Article 517.

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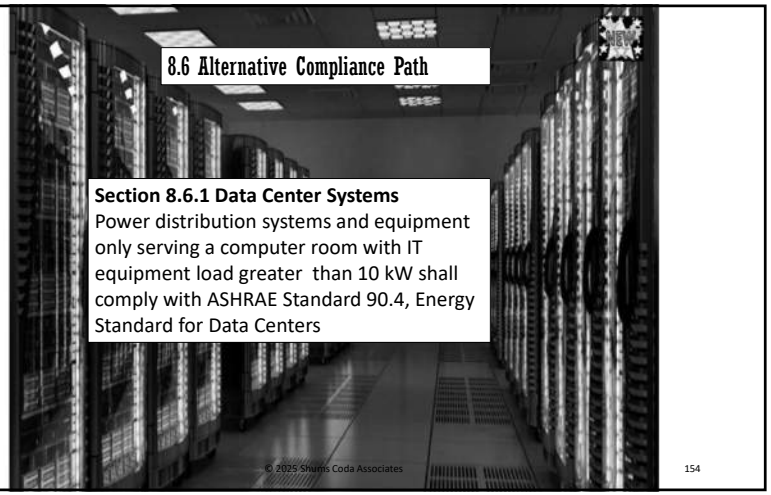

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8.7.3 Completion Requirements

- 8.7.3.1Record Documents
- Construction documents shall require that within 90 days after the date of system acceptance, record documents shall be provided to the building owner, including
- a. a single-line diagram of the building electrical distribution system and
- b. floor plans indicating location and area served for all distribution

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8.7.3 Completion Requirements

- **8.7.3.2 Manuals**
- Construction documents shall require that an operating manual and maintenance manual be provided to the building owner. The manuals shall include, at a minimum, the following:
- a. Submittal data stating equipment rating and selected options for each piece of equipment requiring maintenance.
- b. Operation manuals and maintenance manuals for each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
- c. Names and addresses of at least one qualified service agency.
- d. A complete narrative of how each system is intended to operate.
- Enforcement agencies should only check to ensure that the construction documents require this information to be transmitted to the owner and should not expect copies of any of the materials.

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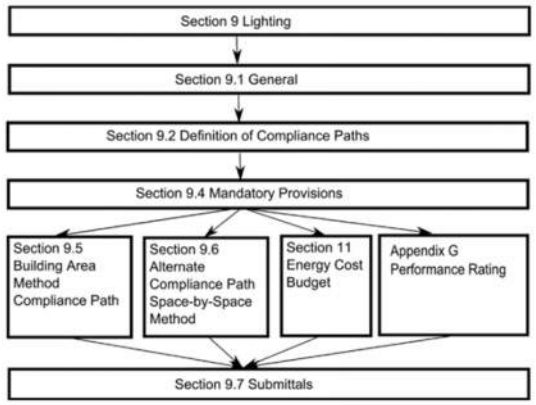

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Lighting 9.1 General

- **9.1.2 Lighting Alterations**
- For the alteration of any lighting system in an interior space, that space shall comply with the lighting power density (LPD) allowances of Section 9.5.1 or 9.6.1 and the control requirements of Section 9.4.1.1 (a), (b), (c), (d), (g), (h), and (i), as applicable to that space.
- For the alteration of any lighting system for the exterior of a building application, that lighting system shall comply with the lighting power density (LPD) allowances of Section 9.4.2 applicable to the area illuminated by that lighting system and the applicable control requirements of Sections 9.4.1.4 and 9.4.2.

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Lighting 9.1 General

Exception to 9.1.2

1. Alterations that involve 20% or less of the connected lighting load in a space or area need not comply with these requirements, provided that such alterations do not increase the installed lighting power.

2. Lighting alterations that only involve replacement of lamps plus ballasts/drivers or only involve one-for-one luminaire replacement need only comply with LPD requirement and Section 9.4.1.1(h) or 9.4.1.1(i).

3. Routine maintenance or repair situations

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9.2 Compliance Paths
Lighting systems and equipment shall comply with Section 9.2.1 and Section 9.2.2.

9.2.1 Requirements for All Compliance Paths
Lighting systems and equipment shall comply with Section 9.1 "General"; Section 9.4, "Mandatory Provisions"; and Section 9.7, "Submittals. Compliance with Section 9 shall be achieved by meeting all of the requirements of Section 9.1, "General"; Section 9.7, "Submittals"; and one of the following:

a. Section 9.3, "Simplified Building Method Compliance Path"
b. Section 9.4, "Mandatory Provisions", and Section 9.5, "Building Area Method"
c. Section 9.4, "Mandatory Provisions," and Section 9.6, "Space-by-Space Method"

The installed lighting power identified in accordance with Section 9.1.3 shall not exceed the lighting power allowance developed in accordance with Section 9.2.1(a), (b), or (c).

Trade-offs of lighting power allowance among portions of the building for which a different calculation method has been used for compliance are not permitted.

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9.3 Simplified Building Method Compliance Path

The Simplified Building Method contains the requirements for interior lighting in Section 9.3.1 and exterior lighting in Section 9.3.2 and shall be allowed to be used where at least 80% of the floor area supports either office buildings, retail buildings, or school buildings. The Simplified Building Method shall be used for new buildings or tenant improvements of less than 25,000 ft2. Interior and exterior wattage allowances shall be calculated and complied with separately.

9.3.1 Simplified Building Method of Calculating Interior Lighting Power Allowance

Buildings (new and alterations) shall comply with the lighting power allowance and control requirements of Tables 9.3.1-1, 9.3.1-2, and 9.3.1-3.

9.3.2 Simplified Building Method of Calculating Exterior Lighting Power Allowance

For all building types listed in Section 9.3, exterior areas (new and alterations) shall comply with the lighting power allowance and control requirements of Tables 9.3.1-1, 9.3.1-2, and 9.3.1-3.

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Table 9.3.1-1 Simplified Building Method for Office *Buildings*

Interior *Space* Type	Interior Lighting Power Allowance	*Controls* [a]
All *spaces* in office *buildings* other than parking garages, stairwells, and corridors	0.70 W/ft^2	All lighting shall be *automatically* controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. (**Exception:** Lighting load not exceeding 0.02 W/ft^2 multiplied by the gross lighted area of the *building* shall be permitted to operate at all times.) Each *space* shall have a *manual control* device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off.
Office *spaces* less than or equal to 250 ft^2, classrooms, conference rooms, meeting rooms, training rooms, storage rooms, and break rooms	0.70 W/ft^2	These *spaces* shall also be controlled by *manual-ON occupant sensors.*
Office *spaces* greater than 250 ft^2 and restrooms	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors.*
Stairwells and corridors in office *buildings* and parking garages	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors* that reduce the lighting power by a minimum of 50% when no activity is detected for not longer than 20 minutes and be controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied.
Parking garages	0.13 W/ft^2	All lighting shall be *automatically* controlled to turn off during garage nonoperating hours. Lighting shall also be controlled by *occupant sensors. Controls* shall reduce the power by a minimum of 50% when no activity is detected for not longer than 20 minutes. No device shall control more than 3600 ft^2.

a. All lights in the space shall be controlled.

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Table 9.3.1-2 Simplified Building Method for Retail *Buildings*

Interior *Space* Type	Interior Lighting Power Allowance	*Controls* [a]
All *spaces* in retail *buildings* other than parking garages, stairwells, and corridors	1.00 W/ft^2	All lighting shall be *automatically* controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. (**Exception:** Lighting load not exceeding 0.02 W/ft^2 multiplied by the gross lighted area of the *building* shall be permitted to operate at all times.) Each *space* shall have a *manual control* device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off.
Sales area	1.00 W/ft^2	These *spaces* shall also be controlled • to reduce the *general lighting* power by a minimum of 75% during nonbusiness hours, • to turn off all lighting other than *general lighting* during nonbusiness hours, and • by *continuous daylight dimming* controls [b] in *spaces* with *toplighting.*
Stock rooms, dressing/fitting rooms, locker rooms, and restrooms	1.00 W/ft^2	These *spaces* shall also be controlled by; *auto-ON* or *manual-ON occupant sensors*, and *continuous daylight dimming* controls [b] in *spaces* with *toplighting.*
Office *spaces*, conference rooms, meeting rooms, training rooms, storage rooms, break rooms, and utility *spaces*	1.00 W/ft^2	These *spaces* shall also be controlled by; *manual-ON occupant sensors*, and *continuous daylight dimming* controls [b] in *spaces* with *toplighting.*
Stairwells and corridors in retail *buildings* and parking garages	1.00 W/ft^2	These *spaces* shall also be controlled by *occupant sensors* that reduce the lighting power by a minimum of 50% when no activity is detected for not longer than 20 minutes and be controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied.
Parking garages	0.13 W/ft^2	All lighting shall be *automatically* controlled to turn off during garage nonoperating hours. Lighting shall also be controlled by *occupant sensors. Controls* shall reduce the power by a minimum of 50% when no activity is detected for not longer than 20 minutes. No device shall control more than 3600 ft^2.

a. All lights in the space shall be controlled.
b. When the combined input power of the general lights completely or partially within the *daylight areas* is 150 W or greater.

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Table 9.3.1-3 Simplified Building Method for School *Buildings*

Interior *Space* Type	Interior Lighting Power Allowance	*Controls* [a]
All *spaces* in school *buildings* other than parking garages, stairwells, and corridors	0.70 W/ft^2	All lighting shall be *automatically* controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. (**Exception:** Lighting load not exceeding 0.02 W/ft^2 multiplied by the gross lighted area of the *building* shall be permitted to operate at all times.) Each *space* shall have a *manual control* device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off.
Classrooms, offices *spaces*, conference rooms, meeting rooms, library, storage rooms, and break rooms	0.70 W/ft^2	These *spaces* shall also be controlled by *manual-ON occupant sensors.*
Gymnasiums and cafeterias	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors.*
Restrooms	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors.*
Stairwells and corridors in school *buildings* and parking garages	0.70 W/ft^2	These *spaces* shall also be controlled by *occupant sensors* that reduce the lighting power by a minimum of 50% when no activity is detected for not longer than 20 minutes and be controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied.
Parking garages	0.13 W/ft^2	All lighting shall be *automatically* controlled to turn off during garage nonoperating hours. Lighting shall also be controlled by *occupant sensors. Controls* shall reduce the power by a minimum of 50% when no activity is detected for not longer than 20 minutes. No device shall control more than 3600 ft^2.

a. All lights in the space shall be controlled.

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Table 9.3.2 Simplified Building Method for *Building* Exteriors

Exterior Area Type	*Exterior Lighting Power Allowance*[a,b]	*Controls*[c]
Base allowance	200 W	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Façade lighting and special feature areas, walkways, plazas	0.10 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Landscape	0.04 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Entry doors	14 W/linear foot	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.
Stairs and ramps	0.7 W/ft^2	No additional *controls* required.
Parking lots and drives	0.05 W/ft^2	*Luminaires* mounted 25 ft or less above grade shall be controlled to reduce the power by at least 50% when no activity is detected for not longer than 15 minutes.
All other areas not listed	0.20 W/ft^2	*Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours.

a. To calculate the exterior allowance, multiply the *space* or area square footage by the allowed W/ft^2 and sum the exterior allowances and the base allowance. Façade lighting shall be calculated separately by multiplying the façade area by the allowed W/ft^2. Façade allowance shall not be traded with other exterior areas or between separate *façade areas*.
b. For *buildings* in Lighting Zone 2, as defined in Table 9.4.2-1, decrease exterior allowances by 20%. For *buildings* in Lighting Zone 4, as defined in Table 9.4.2-1, increase exterior allowances by 25%.
c. All exterior lighting shall be automatically controlled by either a photocell or an astronomical time switch to shut off the lighting when daylight is available.

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LIGHTING
9.4 Mandatory Provisions

Interior Lighting Controls 9.4.1.1

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9.4.1.1 Interior Lighting Controls
For each space in the building, all of the lighting control functions indicated in Table 9.6.1, for the appropriate space type in the first column, and as described below, shall be implemented.

All control functions indicated as “REQ” are mandatory and shall be implemented.

If a space type has control functions indicated as “ADD1,” then at least one of those functions shall be implemented.

If a space type has control functions indicated as “ADD2,” then at least one of those functions shall be implemented.

For space types not listed, select a reasonably equivalent type.

If using the Space-by-Space Method, the space type used for determining control requirements shall be the same space type that is used for determining the LPD allowance.

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- **a. Local control:** There shall be one or more manual lighting controls in the space that controls all of the lighting in the space.
- Each control device shall control an area

  (1) no larger than 2500 ft2 if the space is ≤ 10,000 ft2 and

  (2) no larger than 10,000 ft2 otherwise.
- The device installed to comply with this provision shall be readily accessible and located so that the occupants can see the controlled lighting when using the control device.

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- b. *Restricted to manual* ON*:* None of the lighting shall be automatically turned on.
- Exceptions

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- *c. Restricted to partial automatic ON:*
- No more than 50% of the lighting power for the *general lighting* shall be allowed to be automatically turned on, and none of the remaining lighting shall be automatically turned on.
- Exceptions

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- d. *Bilevel lighting control:*
- The *general lighting* in the *space* shall be controlled so as to provide at least one intermediate step in lighting power or continuous dimming in addition to full ON and full OFF. At least one intermediate step shall be between 30% and 70% (inclusive) of full lighting power.
- Exceptions

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- e. *Automatic daylight responsive controls for sidelighting:*
- In any *space* where the combined input power of all *general lighting* completely or partially within the *primary sidelighted areas* is 150 W or greater, the *general lighting* in the *primary sidelighted areas* shall be controlled by photocontrols.
- Exceptions

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- **e. continued:**
- In any *space* where the combined input power of all *general lighting* completely or partially within the *primary sidelighted area* and *secondary sidelighted area* is 300 W or greater, the *general lighting* in the *primary sidelighted area* and *secondary sidelighted area* shall be controlled by photocontrols. *General lighting* in the *secondary sidelighted area* shall be controlled independently of the *general lighting* in the *primary sidelighted area*.

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- **e. continued:**
- The *control system* shall have the following characteristics:
- 1. The calibration adjustment *control* shall be located no higher than 11 ft above the finished *floor*.
- 2. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or with at least one *control* point between 50% and 70% of design lighting power, a second *control* point between 20% and 40% of design lighting power or the lowest dimming level the technology allows, and a third *control* point that turns off all the controlled lighting.
- 3. The calibration shall not require the physical presence of a person at the sensor while the calibration is processing.

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- f. *Automatic daylight responsive controls for toplighting:*
- In any *space* where the combined input power for all *general lighting* completely or partially within *daylight area under skylights* and *daylight area under roof monitors* is 150 W or greater, *general lighting* in the *daylight area* shall be controlled by photocontrols. The *control system* shall have the following characteristics:

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- **f. Continued**
- 1. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or with at least one *control* point that is between 50% and 70% of design lighting power, a second *control* point between 20% and 40% of design lighting power or the lowest dimming level the technology allows, and a third *control* point that turns off all the controlled lighting.
- 2. The calibration shall not require the physical presence of a person at the sensor while the calibration is processing.
- 3. *General lighting* in overlapping toplighted and sidelighted *daylight areas* shall be controlled together with *general lighting* in the *daylight area under skylights* or *daylight area under roof monitors*.

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9 lighting

9.4.1.1 Interior Lighting Controls

g. *Automatic partial OFF (full OFF complies):*

The *general lighting* power in the *space* shall be automatically reduced by at least 50% within 20 minutes of all occupants leaving the *space*.

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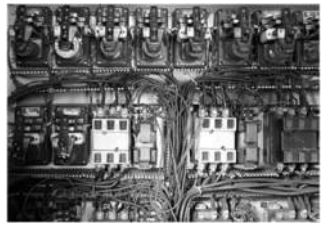
9 lighting

- **9.4.1.1 Interior Lighting Controls**
- h. *Automatic full OFF:*
- All lighting, including lighting connected to emergency circuits, shall be automatically shut off within 20 minutes of all occupants leaving the *space*.
- A *control device* meeting this requirement shall *control* no more than 5000 ft2.



- Exceptions

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9 lighting

- **9.4.1.1 Interior Lighting Controls**
- *i. Scheduled shutoff:*
- All lighting in the *space*, including lighting connected to emergency circuits, shall be automatically shut off during periods when the *space* is scheduled to be unoccupied using either
- (1) a time-of-day operated *control device* that automatically turns the lighting off at specific programmed times or
- (2) a signal from another *automatic control device* or alarm/security *system*. The *control device* or *system* shall provide independent *control* sequences that
- (1) *control* the lighting for an area of no more than 25,000 ft2,
- (2) include no more than one *floor*, and
- (3) shall be programmed to account for weekends and holidays. Any *manual control* installed to provide override of the scheduled shutoff *control* shall not turn the lighting on for more than two hours per activation during scheduled off periods and shall not *control* more than 5000 ft2.

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Table 9.6.1 *Lighting Power Density* Allowances Using the Space-by-Space Method and Minimum *Control* Requirements Using Either Method

Informative Note: This table is divided into two sections; this first section covers *space* types that can be commonly found in multiple *building* types. The second part of this table covers *space* types that are typically found in a single *building* type.			The *control* functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each *space* type: (1) All REQs shall be implemented, (2) At least one ADD1 (when present) shall be implemented, (3) At least one ADD2 (when present) shall be implemented.								
			Local Control (See Section 9.4.1.1[a])	Restricted to *Manual* ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bilevel Lighting *Control* (See Section 9.4.1.1[d])	*Automatic* Daylight Responsive *Controls* for Sidelighting (See Section 9.4.1.1[e][a])	*Automatic* Daylight Responsive *Controls* for Toplighting (See Section 9.4.1.1[f][a])	*Automatic* Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	*Automatic* Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
Common *Space* Types[1]	*LPD* Allowances, W/ft²	*RCR* Threshold	a	b	c	d	e	f	g	h	i
Atrium											
<20 ft in height	0.03/ft total height	NA	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
≥20 ft and ≤40 ft in height	0.03/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
>40 ft in height	0.40 + 0.02/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Audience Seating Area											
Auditorium	0.63	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Convention center	0.82	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Gymnasium	0.65	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Motion picture theater	1.14	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Penitentiary	0.28	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Performing arts theater	2.03	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Religious facility	1.53	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Sports arena	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
All other audience seating areas	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Banking Activity Area	0.86	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3

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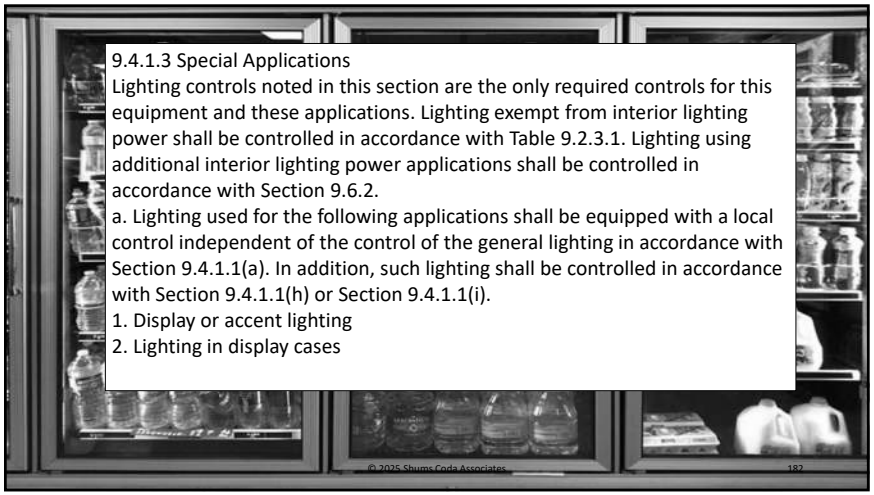

9.4.1.3 Special Applications
Lighting controls noted in this section are the only required controls for this equipment and these applications. Lighting exempt from interior lighting power shall be controlled in accordance with Table 9.2.3.1. Lighting using additional interior lighting power applications shall be controlled in accordance with Section 9.6.2.
a. Lighting used for the following applications shall be equipped with a local control independent of the control of the general lighting in accordance with Section 9.4.1.1(a). In addition, such lighting shall be controlled in accordance with Section 9.4.1.1(h) or Section 9.4.1.1(i).
1. Display or accent lighting
2. Lighting in display cases

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b. Guestrooms
1. All lighting and all switched receptacles in guestrooms and suites in hotels, motels, boarding houses, or similar buildings shall be automatically controlled such that the power to the lighting and switched receptacles in each enclosed space will be turned off within 20 minutes after all occupants leave that space.

Exception to 9.4.1.3(b)(1)

Enclosed spaces where the lighting and switched receptacles are controlled by card key controls and bathrooms are exempt.

2. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting within 30 minutes after all occupants have left the bathroom.

Exception to 9.4.1.3(b)(2)

Night lighting of up to 5 W per bathroom is exempt.

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LIGHTING AND POWER

- c. Supplemental task lighting, including permanently installed undershelf or undercabinet lighting, shall be controlled from either
- 1. a control device integral to the luminaires or
- 2. a local control independent of the control of the general lighting in accordance with Section 9.4.1.1(a).
- In addition, such lighting shall be controlled in accordance with Section 9.4.1.1(h) or Section 9.4.1.1(i).

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4

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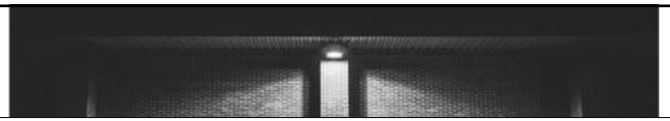

9.4.1.4 Exterior Lighting Control

Lighting for exterior applications not exempted in Section 9.1 shall meet the following requirements:

a. Lighting shall be controlled by a device that automatically turns off the lighting when sufficient daylight is available.

b. All building façade and landscape lighting shall be automatically shut off between mid-night or business closing, whichever is later, and 6 a.m. or business opening, whichever comes first, or between times established by the authority having jurisdiction.

c. Lighting not specified in Section 9.4.1.4(b) and lighting for signage shall be controlled by a device that automatically reduces the connected lighting power by at least 50% for at least one of the following conditions:

1. From 12 midnight or within one hour of the end of business operations, whichever is later, until 6 a.m. or business opening, whichever is earlier

2. During any period when no activity has been detected for a time of no longer than 15 minutes

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LIGHTING AND POWER

- d. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 W and a mounting height of 24 ft or less above the ground shall be controlled to automatically reduce the power of each luminaire by a minimum of 50% when no activity has been detected in the area illuminated by the controlled luminaires for a time of no longer than 15 minutes. No more than 1500 W of lighting power shall be controlled together.
- All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least ten hours.
- **Exception to 9.4.1.4**
- 1. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.
- 2. Lighting that is integral to signage and installed in the signage by the manufacturer.

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4
- Exterior Building Lighting Power 9.4.2

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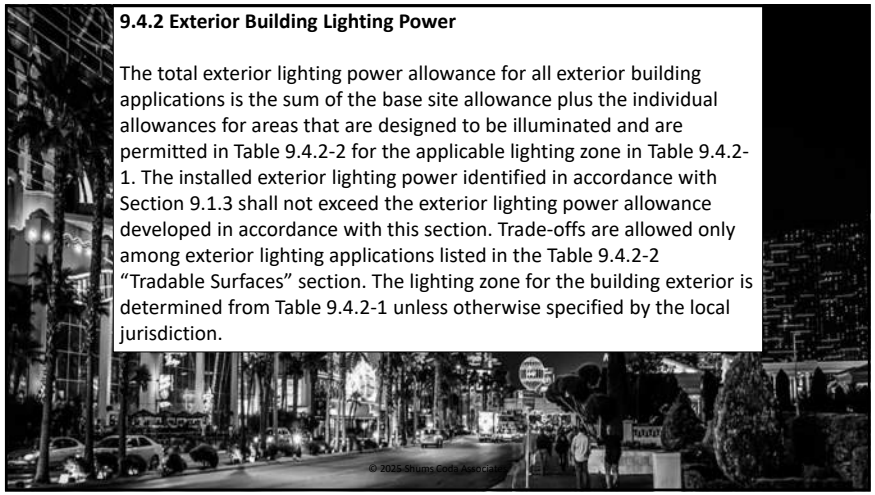

9.4.2 Exterior Building Lighting Power

The total exterior lighting power allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are designed to be illuminated and are permitted in Table 9.4.2-2 for the applicable lighting zone in Table 9.4.2-1. The installed exterior lighting power identified in accordance with Section 9.1.3 shall not exceed the exterior lighting power allowance developed in accordance with this section. Trade-offs are allowed only among exterior lighting applications listed in the Table 9.4.2-2 "Tradable Surfaces" section. The lighting zone for the building exterior is determined from Table 9.4.2-1 unless otherwise specified by the local jurisdiction.

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Exception to 9.4.2

1. Lighting used for the following exterior applications is exempt when equipped with a control device that complies with the requirements of Section 9.4.1.4 and is independent of the control of the nonexempt lighting:
a. Lighting that is integral to signage and installed in the signage by the manufacturer.
b. Lighting for athletic playing areas.
c. Lighting for industrial production, material handling, transportation sites, and associated storage areas.
d. Theme elements in theme/amusement parks.
e. Lighting used to highlight features of public monuments, public art displays, and registered historic landmark structures or buildings.
f. Lighting for water features.
2. Lighting used for the following exterior applications is exempt when controlled separately:
a. Specialized signal, directional, and marker lighting associated with transportation.
b. Lighting integral to equipment or instrumentation and installed by its manufacturer.
c. Lighting for theatrical purposes, including performance, stage, film production, and video production.
d. Temporary lighting.
e. Lighting for hazardous locations.
f. Lighting for swimming pools.
g. Searchlights.

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Lighting Zone	Description
0	Undeveloped areas within national parks, state parks, forest land, rural areas, and other undeveloped areas as defined by the *authority having jurisdiction*
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of *residential* zoning, neighborhood business districts, light industrial with limited nighttime use and *residential* mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local jurisdiction

Table 9.4.2-1
Exterior Lighting Zones

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	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance may be used in tradable or nontradable surfaces.)					
	No allowance	350 W	400 W	500 W	900 W
Tradable Surfaces (*LPD* allowances for uncovered parking areas, *building* grounds, *building entrances*, exits and loading docks, canopies and overhangs, and outdoor sales areas may be traded.)					
Uncovered Parking Areas					
Parking areas and drives	No allowance	0.03 W/ft^2	0.04 W/ft^2	0.06 W/ft^2	0.08 W/ft^2
***Building* Grounds**					
Walkways/ramps less than 10 ft wide	No allowance	0.5 W/linear foot	0.5 W/linear foot	0.6 W/linear foot	0.7 W/linear foot
Walkways/ramps 10 ft wide or greater Plaza areas Special feature areas	No allowance	0.10 W/ft^2	0.10 W/ft^2	0.11 W/ft^2	0.14 W/ft^2
Dining areas	No allowance	0.65 W/ft^2	0.65 W/ft^2	0.75 W/ft^2	0.95 W/ft^2
Stairways	No allowance	0.6 W/ft^2	0.7 W/ft^2	0.7 W/ft^2	0.7 W/ft^2
Pedestrian tunnels	No allowance	0.12 W/ft^2	0.12 W/ft^2	0.14 W/ft^2	0.21 W/ft^2
Landscaping	No allowance	0.03 W/ft^2	0.04 W/ft^2	0.04 W/ft^2	0.04 W/ft^2
***Building Entrances*, Exits, and Loading Docks**					
Pedestrian and vehicular entrances and exits	No allowance	14 W/lin ft of opening	14 W/lin ft of opening	21 W/lin ft of opening	21 W/lin ft of opening
Entry canopies	No allowance	0.20 W/ft^2	0.20 W/ft^2	0.20 W/ft^2	0.20 W/ft^2
Loading docks	No allowance	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2

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Nontradable Surfaces (*LPD* allowances for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)					
Building facades (The allowance for each illuminated facade *orientation* shall be calculated by multiplying the allowable value by the entire façade area or facade length for that *orientation*.)	No allowance	No allowance	0.1 W/ft^2 of *façade area* or 2.5 W/linear foot of façade length	0.15 W/ft^2 of *façade area* or 3.75 W/linear foot of façade length	0.2 W/ft^2 of *façade area* or 5.0 W/linear foot of façade length
Automated teller machines and night depositories	No allowance	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location
Uncovered entrances and gatehouse inspection stations at guarded facilities	No allowance	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2
Uncovered loading areas for law enforcement, fire, ambulance, and other emergency *service* vehicles	No allowance	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
Drive-through windows/*doors*	No allowance	200 W per drive-through	200 W per drive-through	200 W per drive-through	200 W per drive-through
Parking near 24-hour retail entrances	No allowance	400 W per main entry	400 W per main entry	400 W per main entry	400 W per main entry
Roadway/parking entry, trail head, and toilet facility, or other locations approved by the *authority having jurisdiction*.	A single *luminaire* of 25 W or less	No additional allowance	No additional allowance	No additional allowance	No additional allowance

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4
- Exterior Building Lighting Power 9.4.2
- Dwelling Units 9.4.3

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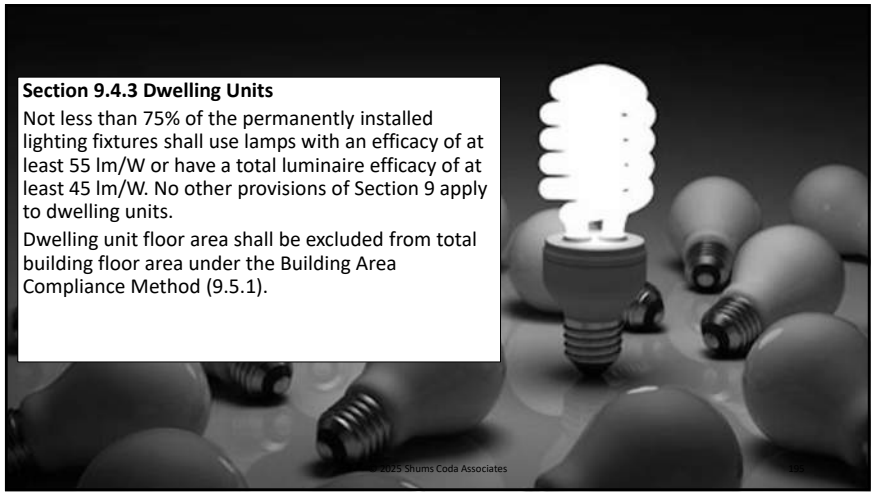

Section 9.4.3 Dwelling Units

Not less than 75% of the permanently installed lighting fixtures shall use lamps with an efficacy of at least 55 lm/W or have a total luminaire efficacy of at least 45 lm/W. No other provisions of Section 9 apply to dwelling units.

Dwelling unit floor area shall be excluded from total building floor area under the Building Area Compliance Method (9.5.1).

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4
- Exterior Building Lighting Power 9.4.2
- Dwelling Units 9.4.3
- Building Area Method of Calculating Interior Power Allowance 9.5

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9.5 Building Area Method Compliance Path

9.5.1 Building Area Method of Calculating Interior Lighting Power Allowance

Use the following steps to determine the interior lighting power allowance by the Building Area Method:

a. Determine the appropriate building area type from Table 9.5.1 and the corresponding LPD allowance. For building area types not listed, selection of a reasonably equiva-lent type shall be permitted.

b. Determine the gross lighted floor area in ft2 of the building area type.

c. Multiply the gross lighted floor areas of the building area types times the LPD.

d. The interior lighting power allowance for the building is the sum of the lighting power allowances of all building area types. Trade-offs among building area types are permitted, provided that the total installed interior lighting power does not exceed the interior lighting power allowance.

Table 9.5.1 Lighting Power Density Allowances Using the Building Area Method

Building Area Type[a]	LPD, W/ft²
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: Bar lounge/leisure	0.80
Dining: Cafeteria/fast food	0.76
Dining: Family	0.71
Dormitory	0.53
Exercise center	0.72
Fire station	0.58
Gymnasium	0.76
Health-care clinic	0.81
Hospital	0.96
Hotel/motel	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multifamily	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious facility	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4
- Exterior Building Lighting Power 9.4.2
- Dwelling Units 9.4.3
- Building Area Method of Calculating Interior Power Allowance 9.5
- Additional Interior Lighting Power – space by space method 9.6.2

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9.6.2 Additional Interior Lighting Power – space by space

When using the Space-by-Space Method, an increase in the interior lighting power allowance is allowed for specific lighting functions. Additional power shall be allowed only if the specified lighting is installed and controlled independently of the general lighting in accordance with Section 9.4.1.1(j). This additional power shall be used only for the specified luminaires and shall not be used for any other purpose unless otherwise indicated. Lighting control requirements referenced in Section 9.6.2 are the only required controls for these applications.

An increase in the interior lighting power allowance is permitted in the following cases:

a. For each space in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits not exempted in Table 9.2.3.1, Item 11, provided that the additional lighting power
shall not exceed 0.75 W/ft2 of such spaces.

b. For lighting equipment installed in sales areas and specifically designed and directed to highlight merchandise, calculate the additional lighting power as follows:

Additional Interior Lighting Power Allowance =
1000 W + (Retail Area 1 × 0.45 W/ft2) + (Retail Area 2 × 0.45 W/ft2) + (Retail Area 3 × 1.05 W/ft2) + (Retail Area 4 × 1.88 W/ft2)

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Where
Retail Area 1 = the floor area for all products not listed in Retail Areas 2, 3, or 4
Retail Area 2 = the floor area used for the sale of vehicles, sporting goods, and small electronics
Retail Area 3 = the floor area used for the sale of furniture, clothing, cosmetics, and artwork
Retail Area 4 = the floor area used for the sale of jewelry, crystal, and china

Exception to 9.6.2

Other merchandise categories may be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the authority having jurisdiction.

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LIGHTING AND POWER

- Interior Lighting Controls 9.4.1.1
- Special appliances 9.4.1.3
- Exterior Lighting Controls 9.4.1.4
- Exterior Building Lighting Power 9.4.2
- Dwelling Units 9.4.3
- Building Area Method of Calculating Interior Power Allowance 9.5
- Additional Interior Lighting Power – space by space method 9.6.2
- Verify 9.7 & 4.2.2

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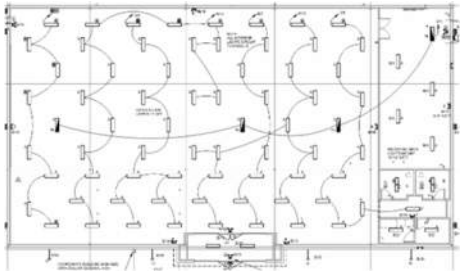

COMcheck Software Version 4.0.0.1
Interior Lighting Compliance Certificate

9.2.2.3 [FI18][1]	Interior installed lamp and fixture lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.
9.4.2 [FI19][1]	Exterior lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.

VERIFY

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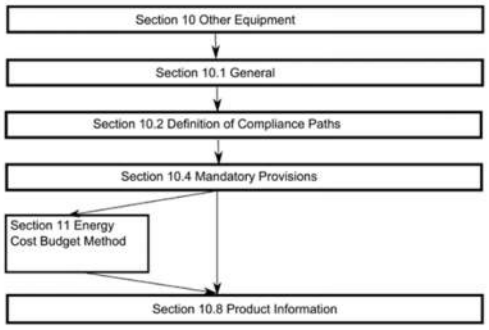

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10.4.3 Elevators
Elevator systems shall comply with the requirements of this section.

10.4.3.1 Lighting
For the luminaires in each elevator cab, not including signals and displays, the sum of the lumens divided by the sum of the watts (as described in Section 9.1.4) shall be no less than 35 lm/W.

10.4.3.2 Ventilation Power Limitation
Cab ventilation fans for elevators without air conditioning shall not consume over 0.33 W/cfm at maximum speed.

10.4.3.3 Standby Mode
When stopped and unoccupied with doors closed for over 15 minutes, cab interior lighting and ventilation shall be de-energized until required for operation.

10.4.3.4 Design Documents
Design documents shall list the following for new elevators:
a. Usage category as defined in ISO 25745-2 between 1 and 6.
b. Energy efficiency classes A through G per ISO 25745-2, Table 7.

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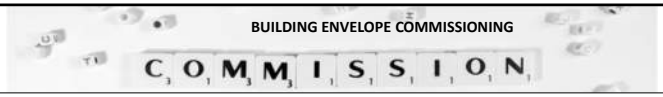

BUILDING ENVELOPE COMMISSIONING

5.9 Verification, Testing, Commissioning, and Inspection

5.9.1 Verification and Testing

5.9.1.1 Building Envelope Performance Verification
The energy performance of the building envelope shall be verified in accordance with this section and Section 4.2.5.1.

5.9.1.2 Verification of the Design and Installation of the Continuous Air Barrier
Verification of the design and installation of the continuous air barrier shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1:
a. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2. (Air Leakage and fenestration and doors)
b. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the continuous air barrier is still accessible for inspection and repair to verify and document compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3. (continuous air barrier design and installation and air leakage)
c. Reporting shall comply with Section 4.2.5.1.2.

5.9.2 Commissioning
The energy performance of the building envelope shall be commissioned in accordance with Section 4.2.5.2. Commissioning reporting shall comply with Section 4.2.5.2.2.

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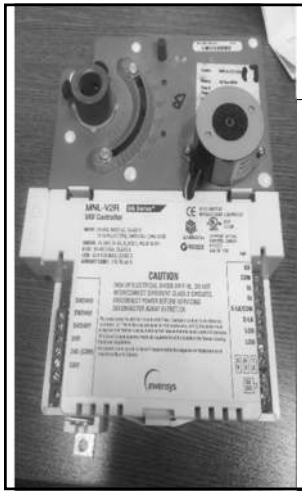

Heating, Ventilating, and Air Conditioning

6.9 Verification, Testing, and Commissioning

6.9.1 Verification and Testing
HVAC control systems shall be tested in accordance with this section and provisions of Section 4.2.5.1. Testing shall verify that systems and control elements are calibrated, adjusted, configured, and operating in accordance with applicable requirements of Sections 6.3, 6.4, and 6.5. Verification and FTP documentation shall comply with Section 4.2.5.1.2.

6.9.2 Commissioning
The performance of the mechanical systems shall be commissioned in accordance with Section 4.2.5.2 Detailed instructions for commissioning HVAC systems shall be provided in the construction documents. Commissioning reporting shall comply with Section 4.2.5.2.2.

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Service Water Heating

7.9 Verification, Testing, and Commissioning

7.9.1 Verification and Testing

Service hot-water controls shall be verified and tested in accordance with this section and provisions of Section 4.2.5.1. Testing shall verify that systems and controls are configured and operating in accordance with applicable requirements of:

a. service water heating system temperature controls (Sections 7.4.4.1 and 7.4.4.3),

b. recirculation pump or heat trace controls (Section 7.4.4.2), or

c. pool time switch controls (Section 7.4.5.3).

Verification and FTP documentation shall comply with Section 4.2.5.1.2.

7.9.2 Commissioning

The energy performance of the service water heating systems shall be commissioned in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.

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POWER

8.9 Verification, Testing, and Commissioning

8.9.1 Verification and Testing
Automatic receptacles controls (Section 8.4.2) and energy monitoring (Section 8.4.3) shall be verified and tested in accordance with this section and provisions of Section 4.2.5.1. Testing shall verify that control elements are configured and operating in accordance with Sections 8.4.2 and 8.4.3. Verification and FPT documentation shall comply with Section 4.2.5.1.

8.9.2 Commissioning
The energy performance of the power systems shall be commissioned in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.

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LIGHTING

- **9.9 Verification, Testing, and Commissioning**

- **9.9.1 Verification and Testing**
- Lighting control devices and control systems shall be tested in accordance with this section and Section 4.2.5.1 to verify that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. When occupancy sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

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LIGHTING

a. Occupancy Sensors
1. Certify that the sensor has been located and aimed in accordance with manufacturer
recommendations.
2. For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.
3. For projects with more than seven (7) occupancy sensors, testing shall be performed for each unique combination of sensor type and space geometry.
(a) For each sensor to be tested, verify the following:
(1) Status indicator (as applicable) operates correctly.
(2) Controlled lights turn off or down to the permitted level within the required time.
(3) For auto-ON occupancy sensors, the lights turn on to the permitted level when someone enters the space.
(4) For manual-ON sensors, the lights turn on only when manually activated.
(5) The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation.

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LIGHTING

b. Automatic Time Switches
1. Confirm that the automatic time-switch control is programmed with weekday, weekend, and holiday (as applicable) schedules.
2. Document for the owner automatic time-switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
3. Verify that correct time and date are properly set in the time switch.
4. Verify that any battery backup (as applicable) is installed and energized.
5. Verify that the override time limit is set to no more than two (2) hours.
6. Simulate occupied condition. Verify and document the following:
(a) All lights can be turned on and off by their respective area control switch.
(b) The switch only operates lighting in the enclosed space in which the switch is located.
7. Simulate unoccupied condition. Verify and document the following:
(a) All nonexempt lighting turns off.
(b) Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shut off occurs.

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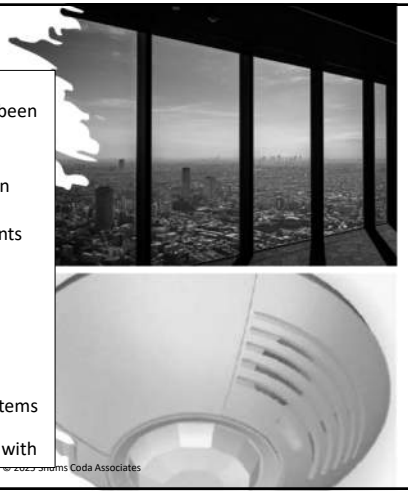
LIGHTING

c. Daylight Controls
1. All control devices (photocontrols) have been properly located and field-calibrated,
to set points and threshold light levels.
2. Daylight controlled lighting loads adjust in response to available daylight.
3. The location where calibration adjustments are made is readily accessible only to
authorized personnel. Verification and FTP documentation shall comply with Section 4.2.5.1.2.

9.9.2 Commissioning

The energy performance of the lighting systems shall be commissioned in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.



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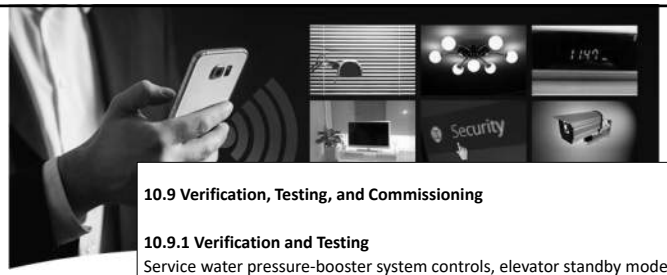

OTHER EQUIPMENT

10.9 Verification, Testing, and Commissioning

10.9.1 Verification and Testing

Service water pressure-booster system controls, elevator standby mode and whole-building energy monitoring shall be commissioned or verified and tested to verify that control elements and monitoring systems are configured and operating in accordance with Sections 10.4.2, 10.4.3.3, 10.4.5, and 4.2.5.2. FPT documentation shall comply with Section 4.2.5.1.2.

10.9.2 Commissioning

The energy performance of the other equipment systems shall be commissioned in accordance with Section 4.2.5.2 and reporting shall comply with Section 4.2.5.2.2.

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4.2.5.2 Building Commissioning Requirements

Commissioning shall be performed in accordance with this section and Sections 5.9.2, 6.9.2, 7.9.2, 8.9.2, 9.9.2, 10.9.2, 11.2(d), and G1.2.1(c). Commissioning shall use ASHRAE/IES Standard 202 or other generally accepted engineering standards acceptable to the building official. FPT and verification requirements for commissioning are as stated in Section 4.2.5.1. Commissioning shall also document in sufficient detail compliance of the building systems, controls, and building envelope with required provisions of this standard. Commissioning requirements shall be incorporated into the construction documents.

The commissioning provider shall have the necessary training, experience, and FPT equipment. The commissioning team shall include V&T providers. The commissioning provider shall be (a) a third-party entity not associated with the building project, (b) owner's qualified employees, or (c) an individual associated with the design firm or contractor but not directly associated with design or installation of the building systems, controls, or building envelope being commissioned.

Exceptions to 4.2.5.2

1. Buildings, additions, or alterations with less than 10,000 ft2 of conditioned space and combined heating, cooling, and service water heating equipment totaling less than 960,000 Btu/h in capacity.
2. Buildings or portions of buildings that use the Simplified Approach Option for HVAC Systems in Section 6.3.
3. Dwelling units.
4. Nonrefrigerated warehouses.

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4.2.5.2.2 Project Commissioning Documents

Project commissioning documents shall comply with ASHRAE/IES Standard 202 or other generally accepted engineering standards acceptable to the building official. The commissioning provider shall certify completion of the required commissioning process and provide the following documents to the owner and design teams:

a. Commissioning Plan. Identify FPT or verification procedures for all systems to be verified, commissioned, or tested.

b. Design Review Report. Detail compliance of the design with the Owner's Project Requirements and provisions of this standard. This commissioning design review shall not be considered a design peer review or a code or regulatory review.

c. Preliminary Commissioning Report. The preliminary commissioning report shall include the following:

1. Required performance of commissioned equipment, systems, and assemblies, and results of FPT and verification
2. Summary of compliance of the building and its components, assemblies, controls, and systems with required provisions of this standard
3. Issues and resolution logs, including itemization of deficiencies found during verification, testing, and commissioning that have not been corrected at the time of report preparation
4. Deferred tests that cannot be performed at the time of report preparation
5. Documentation of the training of operating personnel and building occupants on commissioned systems, and a plan for the completion of any deferred trainings not completed at the time of report preparation
6. A plan for the completion of commissioning and training, including climatic and other conditions required for performance of the deferred tests

d. Final Commissioning Report. The construction documents shall require the commissioning provider to provide a final commissioning report to the owner before completion of the contractor's general warranty period.

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Performance Chapter 11 and Appendix G

- https://www.energycodes.gov/performance_based_compliance
- COMcheck

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