CHAPTER 8

DESIGN BY ACCEPTABLE PRACTICE FOR COMMERCIAL BUILDINGS

SECTION 801 SCOPE

801.1 General. The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings. Buildings constructed in accordance with this chapter are deemed to comply with this code.

801.2 Application. The requirements in Sections 802, 803, 804 and 805 shall each be satisfied on an individual basis. Where one or more of these sections is not satisfied, compliance for that section(s) shall be demonstrated in accordance with the applicable provisions of ASHRAE/IESNA *Energy Code for Commercial and High-Rise Residential Buildings.*

Exception: Buildings meeting Section 806 provided Sections 802.1.2, 802.3, 803.2.1 or 803.3.1 as applicable, 803.2.2 or 803.3.2 as applicable, 803.2.3 or 803.3.3 as applicable, 803.2.8 or 803.3.6 as applicable, 803.2.9 or 803.3.7 as applicable, 804, 805.2, 805.3, and 805.5 are each satisfied.

SECTION 802 BUILDING ENVELOPE REQUIREMENTS

802.1 General. Walls, roof assemblies, floors, glazing, and slabs on grade which are part of the building envelope for buildings where the window and glazed door area is not greater than 50 percent of the gross area of above-grade walls shall meet the requirements of Sections 802.2.1 through 802.2.8, as applicable. Buildings with more glazing shall meet the applicable provisions of ASHRAE/IESNA *Energy Code for Commercial and High-Rise Residential Buildings.*

Comm 63.0802 (1) Additional building envelope requirements. Glazed structures or glazed portions of buildings used for the production of plant life or for maintaining plant life as the primary purpose of the structure are exempt from the building envelope requirements. When the glazed areas are attached to a building with a different class of construction, these glazed areas shall be separated from the remainder of the building with construction material complying with the building envelope requirements.

802.1.1 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section 802.1.1.1, 802.1.1.2 or 802.1.1.3.

802.1.1.1 Above-grade walls. Above-grade walls are those walls covered by Section 802.2.1 on the exterior of the building and completely above grade or the above-grade portion of a basement or first-story wall that is more than 15 percent above grade.

802.1.1.2 Below-grade walls. Below-grade walls covered by Section 802.2.8 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

802.1.1.3 Interior walls. Interior walls covered by Section 802.2.9 are those walls not on the exterior of the building and that separate conditioned and unconditioned space.

802.1.2 [Comm 63.0802 (2)] Moisture control.

(a) **General.** Except as specified in par. (b), vapor retarders shall be provided on all warm-in-winter sides of frame walls, floors and ceilings. The vapor retarder shall have a maximum permeance rating of 1.0 perm when tested in accordance with Procedure A of the ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials.

(b) **Other approved means.** Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided.

802.2 Criteria. The building envelope components shall meet each of the applicable requirements in Tables 802.2(1), 802.2(2), 802.2(3) and 802.2(4) based on the percentage of wall that is glazed. The percentage of wall that is glazed shall be determined by dividing the aggregate area of rough openings for glazing (windows and glazed doors) in all the above-grade walls associated with the building envelope by the total gross area of all above-grade exterior walls that are a part of the building envelope. In buildings with multiple types of building envelope construction, each building envelope construction type shall be evaluated separately. Where Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4) does not list a particular construction type, the applicable provisions of ASHRAE/IESNA *Energy Code for Commercial and High-Rise Residential Buildings* shall be used in lieu of Section 802.

802.2.1 Above-grade walls. The minimum thermal resistance (*R*-value) of the insulating material(s) installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4), based on framing type and construction materials used in the wall assembly. Where both cavity and continuous insulation values are provided in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4), both requirements shall be met. Concrete masonry units (CMU) at least 8-inch (203 mm) nominal thickness with essentially equal amounts of mass on either side of the insulation layer are considered as having integral insulation, however, the thermal resistance of that insulation shall not be considered when determining compliance with Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4). "Other masonry walls" shall include walls weighing at least 35 lb/ft^2 (170 kg/m^2) of wall surface area and do not include CMUs less than 8 inches (203 mm) nominal thickness.

Tables 802.2(5) through (32) and 802.2(36) through (37). Deleted.

TABLE 802.2(1)
BUILDING ENVELOPE REQUIREMENTS[a through e]
WINDOW AND GLAZED DOOR AREA 10 PERCENT OR LESS OF ABOVE-GRADE WALL AREA

ELEMENT	CONDITION/VALUE		
Skylights (*U*-factor)			
Slab or below-grade wall (*R*-value)			
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25			
0.25 ≤ PF < 0.50			
PF ≥ 0.50			
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Metal purlin with thermal block			
Metal purlin without thermal block			
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed *R*-value cavity	NA		
R-value continuous	NA		
CMU, ≥ 8 in, with integral insulation *R*-value cavity	NA		
R-value continuous			
Other masonry walls *R*-value cavity	NA		
R-value continuous			

For SI: 1 inch = 25.4 mm.

a. Values shall be determined from Tables 802.2(5) through 802.2(37) using the climate zones specified in Table 302.1. (Note: The tables begin on page EC-54)

b. "NA" indicates the condition is not applicable.

c. An *R*-value of zero indicates no insulation is required.

d. "Any" indicates any available product will comply.

e. "X" indicates no complying option exists for this condition.

TABLE 802.2(2)
BUILDING ENVELOPE REQUIREMENTS[a through e]
WINDOW AND GLAZED DOOR AREA OVER 10 PERCENT BUT NOT GREATER THAN 25 PERCENT OF ABOVE-GRADE WALL AREA

ELEMENT	CONDITION/VALUE		
Skylights (*U*-factor)			
Slab or below-grade wall (*R*-value)			
Windows and glass doors	SHGC	*U*-factor	
PF < 0.25			
0.25 ≤ PF < 0.50			
PF ≥ 0.50			
Roof assemblies (*R*-value)	Insulation between framing	Continuous insulation	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Metal purlin with thermal block			
Metal purlin without thermal block			
Floors over outdoor air or unconditioned space (*R*-value)	Insulation between framing	Continuous insulation	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Above-grade walls (*R*-value)	No framing	Metal framing	Wood framing
Framed *R*-value cavity	NA		
R-value continuous	NA		
CMU, ≥ 8 in, with integral insulation *R*-value cavity	NA		
R-value continuous			
Other masonry walls *R*-value cavity	NA		
R-value continuous			

For SI: 1 inch = 25.4 mm.
a. Values shall be determined from Tables 802.2(5) through 802.2(37) using the climate zones specified in Table 302.1. (Note: The tables begin on page EC-54)
b. "NA" indicates the condition is not applicable.
c. An *R*-value of zero indicates no insulation is required.
d. "Any" indicates any available product will comply.
e. "X" indicates no complying option exists for this condition.

TABLE 802.2(3)
BUILDING ENVELOPE REQUIREMENTS[a through e]
WINDOW AND GLAZED DOOR AREA OVER 25 PERCENT BUT NOT GREATER THAN 40 PERCENT OF ABOVE-GRADE WALL AREA

ELEMENT	CONDITION/VALUE		
Skylights (*U*-factor)			
Slab or below-grade wall (*R*-value)			
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25			
0.25 ≤ PF < 0.50			
PF ≥ 0.50			
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Metal purlin with thermal block			
Metal purlin without thermal block			
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed *R*-value cavity	NA		
R-value continuous	NA		
CMU, ≥ 8 in, with integral insulation *R*-value cavity	NA		
R-value continuous			
Other masonry walls *R*-value cavity	NA		
R-value continuous			

For SI: 1 inch = 25.4 mm.

a. Values shall be determined from Tables 802.2(5) through 802.2(37) using the climate zones specified in Table 302.1. (Note: The tables begin on page EC-54)

b. "NA" indicates the condition is not applicable.

c. An *R*-value of zero indicates no insulation is required.

d. "Any" indicates any available product will comply.

e. "X" indicates no complying option exists for this condition.

TABLE 802.2(4)
BUILDING ENVELOPE REQUIREMENTS[a through e]
WINDOW AND GLAZED DOOR AREA OVER 40 PERCENT BUT NOT GREATER THAN 50 PERCENT OF ABOVE-GRADE WALL AREA

ELEMENT	CONDITION/VALUE		
Skylights (*U*-factor)			
Slab or below-grade wall (*R*-value)			
Windows and glass doors	SHGC	*U*-factor	
PF < 0.25			
0.25 ≤ PF < 0.50			
PF ≥ 0.50			
Roof assemblies (*R*-value)	Insulation between framing	Continuous insulation	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Metal purlin with thermal block			
Metal purlin without thermal block			
Floors over outdoor air or unconditioned space (*R*-value)	Insulation between framing	Continuous insulation	
All-wood joist/truss			
Metal joist/truss			
Concrete slab or deck			
Above-grade walls (*R*-value)	No framing	Metal framing	Wood framing
Framed *R*-value cavity	NA		
R-value continuous	NA		
CMU, ≥ 8 in, with integral insulation *R*-value cavity	NA		
R-value continuous			
Other masonry walls *R*-value cavity	NA		
R-value continuous			

For SI: 1 inch = 25.4 mm.

a. Values shall be determined from Tables 802.2(5) through 802.2(37) using the climate zones specified in Table 302.1. (Note: The tables begin on page EC-54)

b. "NA" indicates the condition is not applicable.

c. An *R*-value of zero indicates no insulation is required.

d. "Any" indicates any available product will comply.

e. "X" indicates no complying option exists for this condition.

TABLE 802.2(33)
BUILDING ENVELOPE REQUIREMENTS[a through e] - CLIMATE ZONE 15

WINDOW AND GLAZED DOOR AREA 10 PERCENT OR LESS OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-0		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	Any	0.7	
0.25 ≤ PF < 0.50	Any	0.7	
PF ≥ 0.50	Any	0.7	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-19	
Metal joist/truss	R-25	R-20	
Concrete slab or deck	NA	R-19	
Metal purlin with thermal block	R-30	R-20	
Metal purlin without thermal block	X	R-20	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-11
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0

WINDOW AND GLAZED DOOR AREA OVER 10 PERCENT BUT NOT GREATER THAN 25 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.5	0.5	
0.25 ≤ PF < 0.50	0.6	0.5	
PF ≥ 0.50	0.7	0.5	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-19	
Metal joist/truss	R-25	R-20	
Concrete slab or deck	NA	R-19	
Metal purlin with thermal block	R-30	R-20	
Metal purlin without thermal block	X	R-20	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-11
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0

(continued)

TABLE 802.2(33)—continued
BUILDING ENVELOPE REQUIREMENTS[a through e] - CLIMATE ZONE 15

WINDOW AND GLAZED DOOR AREA OVER 25 PERCENT BUT NOT GREATER THAN 40 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.5	0.4	
0.25 ≤ PF < 0.50	0.6	0.4	
PF ≥ 0.50	0.7	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-11
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-0	R-0

WINDOW AND GLAZED DOOR AREA OVER 40 PERCENT BUT NOT GREATER THAN 50 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.4	0.4	
0.25 ≤ PF < 0.50	0.5	0.4	
PF ≥ 0.50	0.7	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	R-38	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-7	R-4
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-3	R-0

For SI: 1 inch = 25.4 mm.

a. Values from Tables 802.2(5) through 802.2(37) shall be used for the purpose of the completion of Tables 802.2(1) through 802.2(4), as applicable based on window and glazed door area.

b. "NA" indicates the condition is not applicable.

c. An *R*-value of zero indicates no insulation is required.

d. "Any" indicates any available product will comply.

e. "X" indicates no complying option exists for this condition.

TABLE 802.2(34)
BUILDING ENVELOPE REQUIREMENTS[a through e] - CLIMATE ZONE 16

WINDOW AND GLAZED DOOR AREA 10 PERCENT OR LESS OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.7	0.6	
0.25 ≤ PF < 0.50	Any	0.6	
PF ≥ 0.50	Any	0.6	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-19	
Metal joist/truss	R-25	R-20	
Concrete slab or deck	NA	R-19	
Metal purlin with thermal block	R-30	R-20	
Metal purlin without thermal block	X	R-20	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-11
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0

WINDOW AND GLAZED DOOR AREA OVER 10 PERCENT BUT NOT GREATER THAN 25 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.7	0.5	
0.25 ≤ PF < 0.50	Any	0.5	
PF ≥ 0.50	Any	0.5	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-11
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-11	R-11
R-value continuous	R-5	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-11
R-value continuous	R-9	R-3	R-0

(continued)

TABLE 802.2(34)—continued
BUILDING ENVELOPE REQUIREMENTS[a through e] - CLIMATE ZONE 16

WINDOW AND GLAZED DOOR AREA OVER 25 PERCENT BUT NOT GREATER THAN 40 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.5	0.4	
0.25 ≤ PF < 0.50	0.6	0.4	
PF ≥ 0.50	0.7	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-13
R-value continuous	R-9	R-3	R-0
WINDOW AND GLAZED DOOR AREA OVER 40 PERCENT BUT NOT GREATER THAN 50 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.4	0.4	
0.25 ≤ PF < 0.50	0.5	0.4	
PF ≥ 0.50	0.7	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	R-38	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-14	R-7
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-13
R-value continuous	R-10	R-3	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-13
R-value continuous	R-9	R-3	R-3

For SI: 1 inch = 25.4 mm.

a. Values from Tables 802.2(5) through 802.2(37) shall be used for the purpose of the completion of Tables 802.2(1) through 802.2(4), as applicable based on window and glazed door area.

b. "NA" indicates the condition is not applicable.

c. An *R*-value of zero indicates no insulation is required.

d. "Any" indicates any available product will comply.

e. "X" indicates no complying option exists for this condition.

TABLE 802.2(35)
BUILDING ENVELOPE REQUIREMENTS[b through f] - CLIMATE ZONE 17

WINDOW AND GLAZED DOOR AREA 10 PERCENT OR LESS OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.7	0.5	
0.25 ≤ PF < 0.50	Any	0.5	
PF ≥ 0.50	Any	0.5	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-0	R-0

WINDOW AND GLAZED DOOR AREA OVER 10 PERCENT BUT NOT GREATER THAN 25 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.7	0.4	
0.25 ≤ PF < 0.50	Any	0.4	
PF ≥ 0.50	Any	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-3	R-0
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-11
R-value continuous	R-6	R-0	R-0
Other masonry walls			
R-value cavity	NA	R-13	R-11
R-value continuous	R-9	R-3	R-0

(continued)

TABLE 802.2(35)—continued
BUILDING ENVELOPE REQUIREMENTS[b through f] - CLIMATE ZONE 17

WINDOW AND GLAZED DOOR AREA OVER 25 PERCENT BUT NOT GREATER THAN 40 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC[a]**	***U*-factor**	
PF < 0.25	0.7	0.4	
0.25 ≤ PF < 0.50	Any	0.4	
PF ≥ 0.50	Any	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	X	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-4	R-3
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-13
R-value continuous	R-10	R-4	R-3
Other masonry walls			
R-value cavity	NA	R-13	R-13
R-value continuous	R-10	R-4	R-3
WINDOW AND GLAZED DOOR AREA OVER 40 PERCENT BUT NOT GREATER THAN 50 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	**CONDITION/VALUE**		
Skylights (*U*-factor)	0.6		
Slab or below-grade wall (*R*-value)	R-8		
Windows and glass doors	**SHGC**	***U*-factor**	
PF < 0.25	0.4	0.4	
0.25 ≤ PF < 0.50	0.5	0.4	
PF ≥ 0.50	0.7	0.4	
Roof assemblies (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-30	R-23	
Metal joist/truss	R-30	R-24	
Concrete slab or deck	NA	R-23	
Metal purlin with thermal block	R-38	R-24	
Metal purlin without thermal block	X	R-24	
Floors over outdoor air or unconditioned space (*R*-value)	**Insulation between framing**	**Continuous insulation**	
All-wood joist/truss	R-25	R-22	
Metal joist/truss	R-30	R-23	
Concrete slab or deck	NA	R-22	
Above-grade walls (*R*-value)	**No framing**	**Metal framing**	**Wood framing**
Framed			
R-value cavity	NA	R-13	R-13
R-value continuous	NA	R-14	R-14
CMU, ≥ 8 in, with integral insulation			
R-value cavity	NA	R-13	R-13
R-value continuous	R-14	R-10	R-7
Other masonry walls			
R-value cavity	NA	R-13	R-13
R-value continuous	R-14	R-10	R-7

For SI: 1 inch = 25.4 mm.

a. For buildings over three stories in height, the maximum SHGC shall be 0.60.

b. Values from Tables 802.2(5) through 802.2(37) shall be used for the purpose of the completion of Tables 802.2(1) through 802.2(4), as applicable based on window and glazed door area.

c. "NA" indicates the condition is not applicable.

d. An *R*-value of zero indicates no insulation is required.

e. "Any" indicates any available product will comply.

f. "X" indicates no complying option exists for this condition.

802.2.2 Nonglazed doors. Nonglazed doors shall meet the applicable requirements for windows and glazed doors and be considered as part of the gross area of above-grade walls that are part of the building envelope.

802.2.3 Windows and glass doors. The maximum solar heat gain coefficient (SHGC) and thermal transmittance (*U*-factor) of window assemblies and glass doors located in the building envelope shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4), based on the window projection factor.

The window projection factor shall be determined in accordance with Equation 8-1.

$PF = A/B$ **(Equation 8-1)**

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately, or an area-weighted PF value shall be calculated and used for all windows and glass doors.

802.2.4 Roof assembly. The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4), based on construction materials used in the roof assembly.

Comm 63.0802 (3) Additional roof assembly requirements. The thermal transmittance value for ceilings next to unconditioned spaces shall comply with s. Comm 63.1015 (5).

802.2.5 Skylights. Skylights located in the building envelope shall be limited to 3 percent of the gross roof assembly area and shall have a maximum thermal transmittance (*U*-factor) of the skylight assembly as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4).

802.2.6 Floors over outdoor air or unconditioned space. The minimum thermal resistance (*R*-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4) based on construction materials used in the floor assembly.

802.2.7 Slabs on grade. The minimum thermal resistance (*R*-value) of the insulation around the perimeter of the slab floor shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4). The insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum of 48 inches (1219 mm) or downward to at least the bottom of the slab and then horizontally to the interior or exterior for a minimum total distance of 48 inches (1219 mm).

802.2.8 Below-grade walls. The minimum thermal resistance (*R*-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table 802.2(1), 802.2(2), 802.2(3) or 802.2(4) and shall extend to a depth of 10 feet (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

802.2.9 Interior walls. The minimum thermal resistance (*R*-value) of the insulating material installed in the wall cavity or continuously on the interior walls shall be as specified in Table 802.2(1) for above-grade walls, regardless of glazing area, based on framing type and construction materials used in the wall assembly.

802.3 Air leakage. The requirements for air leakage shall be as specified in Sections 802.3.1 and 802.3.2.

802.3.1 Window, door, and curtain wall assemblies. Window, sliding or swinging doors and curtain wall assemblies that are part of the building envelope shall be tested and listed as meeting AAMA/WDMA 101/I.S.2.

Exception: Site-constructed windows and doors that are weatherstripped or sealed in accordance with Section 802.3.2.

Commercial entrance doors shall have a maximum air infiltration rate of 1.75 cubic feet per minute (cfm)/ft^2 (32.0 m^3/h · m^2) of door area when tested in accordance with ASTM E 283.

802.3.2 Sealing of the building envelope. Openings and penetrations in the building envelope shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and location. Joints and seams shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials spanning joints between construction materials shall allow for expansion and contraction of the construction materials.

Comm 63.0802 (4) Additional sealing of the building envelope requirements. When installed in the building envelope, recessed lighting fixtures shall comply with IECC Section 502.1.3.

SECTION 803
BUILDING MECHANICAL SYSTEMS

803.1 General. This section covers the design and construction of mechanical systems and equipment serving the building heating, cooling, or ventilating needs.

Comm 63.0803 (1) Additional building mechanical systems requirements. Electrical motors shall comply with s. Comm 63.1032.

803.2 Simple HVAC systems and equipment. This section applies to buildings served by unitary or packaged HVAC equipment listed in Tables 803.2.2(1) through 803.2.2(5), each serving one zone and controlled by a single thermostat in the

zone served. It also applies to two-pipe heating systems serving one or more zones, where no cooling system is installed.

This section does not apply to fan systems serving multiple zones, nonunitary or nonpackaged HVAC equipment and systems or hydronic or steam heating and hydronic cooling equipment and distribution systems that provide cooling or cooling and heating which are covered by Section 803.3.

803.2.1 Calculation of heating and cooling loads. Design loads shall be determined in accordance with the procedures described in Chapters 27 and 28 of the ASHRAE *Handbook of Fundamentals* or an approved equivalent computation procedure.

803.2.1.1 [Comm 63.0803 (2) (a)] Equipment and system sizing. Heating and cooling equipment and systems shall be sized to provide the minimum space and system loads calculated in accordance with IECC Section 803.2.1.

803.2.2 HVAC equipment performance requirements. Equipment shall meet the minimum efficiency requirements of Tables 803.2.2(1), 803.2.2(2), 803.2.2(3), 803.2.2(4) and 803.2.2(5), when tested and rated in accordance with the applicable test procedure. The efficiency shall be verified through data furnished by the manufacturer or through certification under an approved certification program. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements.

803.2.3 Temperature and humidity controls. Requirements for temperature and humidity controls shall be as specified in Sections 803.2.3.1 and 803.2.3.2.

803.2.3.1 [Comm 63.0803 (2) (b)] Temperature controls. Each heating and cooling system shall have at least one temperature control device that complies with IECC Sections 803.3.3.1.1, 803.3.3.2 and 803.3.3.3.

TABLE 803.2.2(1)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EQUIPMENT EFFICIENCY

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]	TEST PROCEDURE
Air conditioners, air cooled	< 65,000 Btu/h	Split system	10.0 SEER*	Note c
		Single package	9.7 SEER*	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	8.9 EER*[b] 8.3 IPLV[b]	Note c
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	8.5 EER*[b] 7.5 IPLV[b]	Note d
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	8.5 EER[b] 7.5 IPLV[b]	Note d
	≥ 760,000 Btu/h	Split system and single package	8.2 EER[b] 7.5 IPLV[b]	Note d
Air conditioners, evaporatively cooled	< 65,000 Btu/h	Split system and single package	9.3 EER* 8.4 IPLV	Note c
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.5 EER*[b] 9.7 IPLV[b]	Note c
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.6 EER*[b] 9.0 IPLV[b]	Note d
	≥ 240,000 Btu/h	Split system and single package	9.6 EER[b] 9.0 IPLV[b]	Note d
Air conditioners, water cooled	< 65,000 Btu/h	—	9.3 EER* 8.3 IPLV	Note c
	≥ 65,000 Btu/h and < 135,000 Btu/h	—	10.5 EER[b]	Note c
	≥ 135,000 Btu/h and < 240,000 Btu/h	—	9.6 EER*[b] 9.0 IPLV[b]	Note d
	≥ 240,000 Btu/h	—	9.6 EER[b] 9.0 IPLV[b]	Note d

For SI: °C = [(°F)-32]/1.8, 1 Btu/h = 0.2931 W.

a. Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the Energy Policy Act of 1992 have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)

b. For units that have a heating section, deduct 0.2 from all required EERs and IPLVs.

c. See ARI 210/240.

d. See ARI 340/360.

* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

TABLE 803.2.2(2)
UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED, MINIMUM EQUIPMENT EFFICIENCY

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]	TEST PROCEDURE
Heat pumps, air cooled (cooling mode)	< 65,000 Btu/h	Split system	10.0 SEER*	Note c
		Single package	9.7 SEER*	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	8.9 EER*[b] 8.3 IPLV[b]	Note c
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	8.5 EER[b] 7.5 IPLV[b]	Note d
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	8.5 EER[b] 7.5 IPLV[b]	Note d
	≥ 760,000 Btu/h	Split system and single package	8.2 EER[b] 7.5 IPLV[b]	Note d
Heat pumps, evaporatively cooled (cooling mode)	< 65,000 Btu/h	Split system and single package	9.3 EER* 8.5 IPLV	Note c
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.5 EER* 9.7 IPLV	Note c
Heat pumps, water cooled, water-source (cooling mode)	< 65,000 Btu/h	85°F entering water 75°F entering water	9.3 EER* 10.2 EER*	Note e
	≥ 65,000 Btu/h and < 135,000 Btu/h	85°F entering water	10.5 EER*	Note e
Groundwater-source (cooling mode)	< 135,000 Btu/h	70°F entering water 50°F entering water	11.0 EER* 11.5 EER*	Note f
Heat pumps, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)	Split system	6.8 HSPF*	Note c
		Single package	6.6 HSPF*	
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air 17°F db/15°F wb outdoor air	3.0 COP* 2.0 COP*	Note c
	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air 17°F db/15°F wb outdoor air	2.9 COP* 2.0 COP*	Note d
	≥ 240,000 Btu/h (cooling capacity)	47°F db/43°F wb outdoor air 17°F db/15°F wb outdoor air	2.9 COP* 2.0 COP*	Note d
Heat pumps, water-cooled water-source (heating mode)	< 135,000 Btu/h (cooling capacity)	70°F entering water	3.8 COP*	Note e
Groundwater-source (heating mode)	< 135,000 Btu/h (cooling capacity)	70°F. entering water 50°F. entering water	3.4 COP* 3.0 COP*	Note f

For SI: °C = [(°F)-32]/1.8, 1 Btu/h = 0.2931 W.

a. Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the Energy Policy Act of 1992 have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)

b. For units that have a heating section, deduct 0.2 from all required EERs and IPLVs.

c. See ARI 210/240.

d. See ARI 340/360.

e. See ARI 320.

f. See ARI 325.

* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

TABLE 803.2.2(3)
PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS ELECTRICALLY OPERATED, MINIMUM EQUIPMENT EFFICIENCY

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]	TEST PROCEDURE
PTAC and PTHP (cooling mode)	All capacities	95°F db outdoor air	10.0 - (0.16 × Cap/1000)[b] EER*	Note c
		82°F db outdoor air	12.2 - (0.20 × Cap/1000)[b] EER*	Note c
PTHP (heating mode)	All capacities	—	2.9 - (0.026 × Cap/1000)[b] COP*	Note c

For SI: °C = [(°F)-32]/1.8, 1 Btu/h = 0.2931 W.

a. Equipment must comply with all efficiencies when multiple efficiencies are indicated. (Note: Products covered by the Energy Policy Act of 1992 have no minimum efficiency requirements for operation at minimum capacity or other than standard rating conditions.)

b. Cap is the rated capacity of the product in Btu/h. If the unit's capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

c. See ARI 310/380.

* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

TABLE 803.2.2(4)
WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, HEATERS, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a,d]	TEST PROCEDURE
Warm air furnace, gas-fired	< 225,000 Btu/h	—	78% AFUE* or 80% E_t[c]	Note e
	≥ 225,000 Btu/h	Maximum capacity	80% E_t	Note f
Warm air furnace, oil-fired	< 225,000 Btu/h	—	78% AFUE* or 80% E_t[c]	Note e
	≥ 225,000 Btu/h	Maximum capacity[b]	81% E_t	Note g
Warm air duct furnace, gas-fired	All capacities	Maximum capacity[b] Minimum capacity	78% E_t 75% E_t	Note h
Warm air unit heater, gas-fired	All capacities	Maximum capacity[b] Minimum capacity	78% E_t 74% E_t	Note i
Warm air unit heater, oil-fired	All capacities	Maximum capacity[b] Minimum capacity	81% E_t 81% E_t	Note j

For SI: 1 Btu/h = 0.2931 W.

a. Equipment must comply with all efficiencies when multiple efficiencies are indicated at different rating conditions.

b. Minimum and maximum ratings as provided for and allowed by the unit's controls.

c. Combination units not covered by NAECA (three-phase power or cooling capacity ≥ 65,000 Btu/h) shall comply with one rating.

d. E_t = Thermal efficiency. See referenced test procedure for detailed discussion.

e. See DOE 10 CFR 430; Subpart B, Appendix E.

f. See ANSI Z21.47.

g. See UL 727.

h. See ANSI Z83.9.

i. See ANSI Z83.8.

j. See UL 731.

* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

TABLE 803.2.2(5)
BOILERS, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a,c]	TEST PROCEDURE
Boilers, gas fired	< 300,000 Btu/h	Hot Water	80% AFUE*	Note d
		Steam	75% AFUE*	Note d
	≥ 300,000 Btu/h	Maximum Capacity[b] Minimum Capacity	80% E_c* 80% E_c	Note e
Boilers, oil fired	< 300,000 Btu/h	—	80% AFUE*	Note d
	≥ 300,000 Btu/h	Maximum Capacity[b] Minimum Capacity	83% E_c* 83% E_c	Note f
Boilers, oil fired (residual)	≥ 300,000 Btu/h	Maximum Capacity[b] Minimum Capacity	83% E_c* 83% E_c	Note f

For SI: Btu/h = 0.2931 W.

a. Equipment must comply with all efficiencies when multiple efficiencies are indicated at different rating conditions.

b. Minimum and maximum ratings as provided for and allowed by the unit's controls.

c. E_c = Combustion efficiency (100 percent less flue losses). See referenced test procedure for detailed discussion.

d. See DOE 10 CFR; Part 430; Subpart B, Appendix N.

e. See HI HBS 86 for Power Boilers. See ANSI Z21.13 for Atomospheric Boilers.

f. See HI HBS 86.

* Minimum efficiencies marked with an asterisk are established by preemptive federal law and are printed for the convenience of the user.

* Minimum efficiencies marked with an asterisk (AFUE and E_c at maximum capacity) are established by preemptive federal law and are printed for the convenience of the user.

803.2.3.2 Humidity controls. When humidistats are installed, they shall prevent the use of fossil fuel or electric power to achieve a humidity below 60 percent when the system controlled is cooling, and above 30 percent when the system controlled is heating.

Comm 63.0803 (2) (c) Additional humidity control requirements. If a system is equipped with a means for adding moisture to maintain specific humidity levels in a zone, a humidistat shall be provided.

803.2.4 Hydronic system controls. Hydronic systems of at least 600,000 British thermal units per hour (Btu/h) (175 860 W) design capacity supplying heated water to comfort conditioning systems shall include controls that meet the requirements of Section 803.3.3.7.

803.2.5 Ventilation. Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *International Mechanical Code.*

803.2.6 [Comm 63.0803 (2) (d)] Cooling with outdoor air. Each fan system shall have economizer controls complying with s. Comm 63.1031.

Exceptions:

1. Where the cooling equipment is covered by the minimum efficiency requirements of Table 803.2.2(1) or 803.2.2(2) and meets the efficiency requirements of Table 803.2.6.
2. Systems with air or evaporatively cooled condensors and which serve spaces with open case refrigeration or that require filtration equipment in order to meet the minimum ventilation requirements of Chapter 4 of the *International Mechanical Code.*

803.2.7 [Comm 63.0803 (2) (e)] Shutoff dampers.

1. **Outdoor air supply and exhaust ducts.** Except as specified in subd. 2., automatic or gravity dampers that close when the system is not operating shall be provided for all outdoor air exhausts and motorized dampers that close when the system is not operating shall be provided on all outdoor air intakes.
2. **Exception:** Outdoor air supply and exhaust ducts restricted by health and life safety requirements are exempt.

803.2.8 [Comm 63.0803 (2) (f)] Duct and plenum insulation and sealing.

1. **Supply and return air ducts and plenums.** Except as specified in subd. 2., all supply ducts and return air ducts and plenums shall be insulated with a minimum of R-4 insulation when located in unconditioned spaces and with a minimum of R-7.5 insulation when located outside the building envelope. When located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by a minimum of R-7.5 insulation. All supply ducts located in plenums within the building envelope shall be insulated to R-4.
2. **Exceptions:**
   a. When located within equipment.
   b. When the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (-8°C).

TABLE 803.2.6
MINIMUM EQUIPMENT EFFICIENCY ECONOMIZER EXCEPTION

TOTAL COOLING CAPACITY OF EQUIPMENT	BUILDING LOCATION		
	Zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15-19	Zones 3a, 3b, 4a, 7a, 8, 9b, 10b, 11b	Zones 4b, 5a, 5b, 6b, 7b
90,000 Btu/h to 134,999 Btu/h	NA	11.4 EER	10.4 EER
135,000 Btu/h to 759,999 Btu/h	NA	10.9 EER	9.9 EER
760,000 Btu/h or more	NA	10.5 EER	9.6 EER

For SI: °C = [(°F)-32]/1.8, 1 Btu/h = 0.2931 W.
NA = Not Applicable.

3. **Joints, longitudinal and transverse seams, and connections.** Joints, longitudinal and transverse seams, and connections in ductwork shall be sealed in accordance with s. Comm 63.1029 (4).

803.2.9 Piping insulation. All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Section 803.3.7.

803.3 Complex HVAC systems and equipment. This section applies to buildings served by HVAC equipment and systems not covered in Section 803.2.

803.3.1 Calculation of heating and cooling loads. Design loads shall be determined in accordance with Section 803.2.1.

803.3.1.1 [Comm 63.0803 (3) (a)] Equipment and system sizing. Heating and cooling equipment and system capacity shall be sized to provide the minimum space and system loads calculated in accordance with IECC Section 803.2.1.

Exceptions:

1. Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.
2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that have the capability to sequence the operation of each unit based on load.

803.3.2 HVAC equipment performance requirements. Equipment shall meet the minimum efficiency requirements of Tables 803.3.2(1) through 803.3.2(3) and Table 803.2.2(5), when tested and rated in accordance with the applicable test procedure. The efficiency shall be verified through data furnished by the manufacturer or through certification under an approved certification program. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrate the combined efficiency of the specified components meets the requirements herein.

Where unitary or prepackaged equipment is used in a complex HVAC system and is not covered by Section 803.3.2, the equipment shall meet the applicable requirements of Section 803.2.2.

803.3.3 HVAC system controls. Each heating and cooling system shall be provided with thermostatic controls as required in Sections 803.3.3.1 through 803.3.3.5.

803.3.3.1 Thermostatic controls. The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls capable of responding to temperature within the zone. Where humidification or dehumidification or both is provided, at least one humidity control device shall be provided for each humidity control system

Exception: Independent perimeter systems that are designed to offset only building envelope heat losses or gains or both serving one or more perimeter zones also served by an interior system provided:

1. The perimeter system includes at least one thermostatic control zone for each building exposure having exterior walls facing only one orientation (within +/- 45°) for more than 50 contiguous feet (15.2 m) and,
2. The perimeter system heating and cooling supply is controlled by a thermostat(s) located within the zone(s) served by the system.

803.3.3.1.1 Heat pump supplementary heat. Heat pumps having supplementary electric resistance heat shall have controls that, except during defrost, prevent supplementary heat operation when the heat pump can meet the heating load.

803.3.3.2 Set point overlap restriction. Where used to control both heating and cooling, zone thermostatic controls shall provide a temperature range or deadband of at

TABLE 803.3.2(1)
CONDENSING UNITS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY[a]	TEST PROCEDURE
Condensing units, air cooled	≥ 135,000 Btu/h	—	9.9 EER 11.0 IPLV	Note b
Condensing units, water or evaporatively cooled	≥ 135,000 Btu/h	—	12.9 EER 12.9 IPLV	

For SI: 1 Btu/h = 0.2931 W.
a. IPLVs are only applicable to equipment with capacity modulation.
b. See ARI 365.

TABLE 803.3.2(2)
WATER CHILLING PACKAGES, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY[a]	TEST PROCEDURE
Air cooled, with condenser, electrically operated	< 150 tons	2.70 COP 2.80 IPLV	Note c
	≥ 150 tons	2.50 COP 2.50 IPLV	
Air cooled, without condenser, electrically operated	All capacities	3.10 COP 3.20 IPLV	
Water cooled, electrically operated	< 150 tons	3.80 COP 3.90 IPLV	
	≥ 150 tons and < 300 tons	4.20 COP 4.50 IPLV	
	≥ 300 tons	5.20 COP[b] 5.30 IPLV	

For SI: 1 Btu/h = 0.2931 W, 1 ton refrigeration = 12,000 Btu/h.
a. Equipment must comply with all efficiencies.
b. These requirements are reduced to 4.70 COP and 4.80 IPLV where R-22 is used or where refrigerants with an ozone depletion factor less than that for R-22 are used.
c. See ARI 550 or 590 as applicable.

TABLE 803.3.2(3)
WARM AIR DUCT FURNACES AND UNIT HEATERS, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION[a]	MINIMUM THERMAL EFFICIENCY	TEST PROCEDURE
Warm air duct furnaces, gas-fired	All capacities	Maximum capacity Minimum capacity	78% E_t 75% E_t	Note b
Warm air unit heaters, gas-fired	All capacities	Maximum capacity Minimum capacity	78% E_t 74% E_t	Note c
Warm air unit heaters, oil-fired	All capacities	Maximum capacity Minimum capacity	81% E_t 81% E_t	Note d

a. Minimum and maximum ratings as provided for and allowed by the unit's controls. Equipment must comply with all efficiencies when multiple efficiencies are indicated.
b. See ANSI Z83.9.
c. See ANSI Z83.8.
d. See UL 731.

least 5°F (Δ 2.8 °C) within which the supply of heating and cooling energy to the zone is capable of being shut off or reduced to a minimum.

Exception: Thermostats requiring manual changeover between heating and cooling modes.

803.3.3.3 Off-hour controls. Each zone shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

Exceptions:

1. Zones that will be operated continuously.
2. Zones with a full HVAC load demand not exceeding 6,800 Btu/h (2 kW) and having a readily accessible manual shutoff switch.

803.3.3.3.1 Thermostatic setback capabilities. Thermostatic setback controls shall have the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C).

803.3.3.3.2 Automatic setback and shutdown capabilities. Automatic time clock or programmable controls shall be capable of starting and stopping the system for seven different daily schedules per week and retaining their programming and time setting during a loss of power for at least 10 hours. Additionally, the controls shall have: a manual override that allows temporary operation of the system for up to 2 hours; a manually operated timer capable of being adjusted to operate the system for up to 2 hours; or an occupancy sensor.

803.3.3.4 [Comm 63.0803 (3)(b)] Shutoff damper controls.

1. Except as specified in subd. 2., automatic or gravity dampers that close when the system is not operating shall be provided for all outdoor air exhausts and motorized dampers that close when the system is not operating shall be provided on all outdoor air intakes.
2. Outdoor air supply and exhaust ducts restricted by health and life safety requirements are exempt.

803.3.3.5 [Comm 63.0803 (3) (c)] Economizers. Each fan system shall have economizer controls complying with s. Comm 63.1031.

803.3.3.6 Variable air volume (VAV) fan control. Individual VAV fans with motors of 25 horsepower (hp) (18.8 kW) or greater shall be driven by a mechanical or electrical variable speed drive; be a vane-axial fan with variable pitch blades; or have controls or devices that will result in fan motor demand of no more than 50 percent of their design wattage at 50 percent of design airflow when static pressure set point equals one-third of the total design static pressure.

803.3.3.7 Hydronic systems controls. Individual hydronic heating and cooling units shall have separate hot water and chilled water supply and return piping. Systems shall not have the capability to supply hot and chilled water concurrently to any terminal unit.

Exception: Zones where special humidity levels are required to satisfy process needs.

803.3.3.7.1 Part load controls. Hydronic systems greater than or equal to 600,000 Btu/h (175 860 W) in design capacity supplying heated or chilled water to comfort conditioning systems shall include controls that have the capability to:

1. Automatically reset the supply water temperatures using zone return water temperature, building return water temperature, or outside air temperature as an indicator of building heating or cooling demand. The temperature shall be capable of being reset by at least 25 percent of the design supply-to-return water temperature difference; or
2. Reduce system pump flow by at least 50 percent of design flow rate utilizing adjustable speed drive(s) on pump(s), utilize multiple staged pumps where at least one-half of the total pump horsepower is capable of being automatically turned off, utilize control valves designed to modulate or step down, and close, as a function of load, or other approved means.

803.3.4 Requirements for complex mechanical systems serving multiple zones. Systems serving multiple zones shall be VAV systems which, during periods of occupancy, are designed and capable of being controlled to reduce primary air supply to each zone to a minimum before reheating, recooling or mixing takes place. Sections 803.3.4.1 through 803.3.4.4 shall apply to complex mechanical systems.

Exceptions:

1. Zones where special pressurization relationships or cross-contamination requirements are such that VAV systems are impractical.
2. Where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site-solar energy source.
3. Zones where special humidity levels are required to satisfy process needs.
4. Zones with a peak supply air quantity of 300 cfm (142 L/s) or less and where the flow rate is less than 10 percent of the total fan system supply airflow rate.
5. Zones where the volume of air to be reheated, recooled, or mixed is no greater than the volume of outside air required to meet the minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.
6. Systems with zone thermostatic and humidistatic controls capable of operating in sequence the supply of heating and cooling energy to the zone and which are capable of preventing reheating, recooling, mixing or simultaneous supply of air

that has been previously mechanically cooled and air that has been previously mechanically heated.

803.3.4.1 Temperature reset for air systems. Controls shall be provided that have the capability to automatically reset the supply air in response to measured parameters representative of building loads or by outside air temperature. Temperature shall be capable of being reset by at least 25 percent of the design supply air to room air temperature difference.

803.3.4.2 Single duct variable air volume (VAV) systems, terminal devices. Single duct VAV systems shall use terminal devices capable of reducing the supply of primary supply air before reheating or recooling takes place.

803.3.4.3 Dual duct and mixing VAV systems, terminal devices. Systems that have one warm air duct and one cool air duct shall use terminal devices which are capable of reducing the flow from one duct to a minimum before mixing of air from the other duct takes place.

803.3.4.4 Single fan dual duct and mixing VAV systems, economizers. Individual dual duct or mixing heating and cooling systems with a single fan and with total capacities greater than 90,000 Btu/h [(26 375 W) 7.5 tons] shall not be equipped with air economizers.

803.3.5 Ventilation. Ventilation shall be in accordance with Section 803.2.5.

803.3.6 Duct and plenum insulation and sealing. All ducts and plenums shall be insulated and sealed in accordance with Section 803.2.8.

Ducts designed to operate at static pressures in excess of 3 inch water gauge (wg) (746 Pa) shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* with the rate of air leakage (*CL*) less than or equal to 6.0 as determined in accordance with Equation 8-2.

$$CL = F \times P^{0.65} \qquad \textbf{(Equation 8-2)}$$

where:

F = The measured leakage rate in cfm per 100 square feet of duct surface.

P = The static pressure of the test.

Documentation shall be furnished by the designer demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

803.3.7 [Comm 63.0803 (3) (d)] Piping insulation. All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with s. Comm 63.1029 (1) and (2).

803.3.8 [Comm 63.0803 (3) (e)] HVAC system completion. Balancing and documentation of HVAC systems shall conform to the IMC.

803.3.8.1 [Comm 63.0803 (3) (e)] Air system balancing. Balancing and documentation of HVAC systems shall conform to the IMC.

803.3.8.2 [Comm 63.0803 (3) (e)] Hydronic system balancing. Balancing and documentation of HVAC systems shall conform to the IMC.

803.3.8.3 [Comm 63.0803 (3) (e)] Manuals. Balancing and documentation of HVAC systems shall conform to the IMC.

SECTION 804
SERVICE WATER HEATING

804.1 General. This section covers the minimum efficiency of and controls for service water-heating equipment and insulation of service hot water piping.

804.2 Service water-heating equipment performance efficiency. Water-heating equipment and hot water storage tanks shall meet the requirements of Table 504.2. The efficiency shall be verified through data furnished by the manufacturer or through certification under an approved certification program.

804.3 Deleted.

804.4 [Comm 63.0804 (2)] Heat traps. Plumbing piping systems, including those without an integral heat trap shall comply with s. Comm 63.1029 (1) and (2).

804.5 [Comm 63.0804 (3)] Pipe insulation. All system piping shall be thermally insulated in accordance with s. Comm 63.1029 (1) and (2).

804.6 Hot water system controls. Automatic circulating hot water systems or heat trace shall have time switches that are capable of being set to turn off the system.

SECTION 805
LIGHTING SYSTEMS

Comm 63.0805 Lighting systems shall comply with ss. Comm 63.1040 to Comm 63.1053.

SECTION 806
TOTAL BUILDING PERFORMANCE

806.1 General. The proposed design complies with this section where annual energy costs of the Proposed design as determined in accordance with Section 806.3 do not exceed those of the Standard design as determined in accordance with Section 806.4.

806.2 Analysis procedures. Sections 806.2.1 through 806.2.8 shall be applied in determining total building performance.

806.2.1 Energy analysis. Annual (8,760 hours) energy costs for the Standard design and the Proposed design shall each be determined using the same approved energy analysis simulation tool.

806.2.2 Climate data. The climate data used in the energy analysis shall cover a full calendar year (8,760 hours) and shall reflect approved coincident hourly data for temperature, solar radiation, humidity and wind speed for the building location.

806.2.3 Energy rates. The annual energy costs shall be estimated using energy rates published by the serving energy

supplier and which would apply to the actual building or *DOE State-Average Energy Prices* published by DOE's Energy Information Administration and which would apply to the actual building.

806.2.4 Nondepletable energy. Nondepletable energy collected offsite shall be treated and priced the same as purchased energy. Energy from nondepletable energy sources collected on site shall be omitted from the annual energy cost of the Proposed design. The analysis and performance of any nondepletable energy system shall be determined in accordance with accepted engineering practice using approved methods.

806.2.5 Building operation. Building operation shall be simulated for a full calendar year (8,760 hours). Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays, and any seasonal operation. Schedules shall model the time-dependent variations of occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage, and any process loads.

806.2.6 Simulated loads. The following systems and loads shall be modeled in determining total building performance: heating systems; cooling systems; fan systems; lighting power; receptacle loads; and process loads that exceed 1.0 W/ft^2 (W/0.0929 m^2) of floor area of the room or space in which the process loads are located.

Exception: Systems and loads serving required emergency power only.

806.2.7 Service water-heating systems. Service water-heating systems that are other than combined service hot water/space-heating systems shall be be omitted from the energy analysis provided all requirements in Section 804 have been met.

806.2.8 Exterior lighting. Exterior lighting systems shall be the same as in the Standard and Proposed designs.

806.3 Determining energy costs for the Proposed design. Building systems and loads shall be simulated in the Proposed design in accordance with Sections 806.3.1 and 806.3.2.

806.3.1 HVAC and service water-heating equipment. All HVAC and service water-heating equipment shall be simulated in the Proposed design using capacities, rated efficiencies, and part-load performance data for the proposed equipment as provided by the equipment manufacturer.

806.3.2 Features not documented at time of permit. If any feature of the Proposed design is not included in the building permit application, the energy performance of that feature shall be assumed to be that of the corresponding feature used in the calculations required in Section 806.4.

806.4 Determining energy costs for the Standard design. Sections 806.4.1 through 806.4.7 shall be used in determining the annual energy costs of the Standard design.

806.4.1 Equipment efficiency. The space-heating, space-cooling, service water-heating, and ventilation systems and equipment meet, but do not exceed, the minimum efficiency requirements of Sections 803 and 804.

806.4.2 HVAC system capacities. HVAC system capacities in the Standard design shall be established such that no smaller number of unmet heating and cooling load hours and no larger heating and cooling capacity safety factors are provided than in the Proposed design.

806.4.3 Envelope. The performance of the elements of the thermal envelope of the Standard design shall be determined in accordance with the requirements of Section 802.2 as applicable.

806.4.4 Identical characteristics. The heating/cooling system zoning, orientation of each building feature, number of floors, and the gross envelope areas of the Standard design shall be the same as those of the Proposed design except as modified by Section 806.4.5 or 806.4.6.

Exception: Permanent fixed or movable external shading devices for windows and glazed doors shall be excluded from the Standard design.

806.4.5 Window area. The window area of the Standard design shall be the same as the Proposed design, or 35 percent of the above-grade wall area, whichever is less, and shall be distributed in a uniform pattern equally over each building façade.

806.4.6 Skylight area. The skylight area of the Standard design shall be the same as the Proposed design, or 3 percent of the gross area of the roof assembly, whichever is less.

806.4.7 Interior lighting. The lighting power for the Standard design shall be the maximum allowed in accordance with Section 805.4. Where the occupancy of the building is not known, the lighting power density shall be 1.5 watts per square foot (16.1 W/m^2).

806.5 Documentation. The energy analysis and supporting documentation shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. The information documenting compliance shall be submitted in accordance with Sections 806.5.1 through 806.5.4

806.5.1 Annual energy use and associated costs. The annual energy use and costs by energy source of the Standard design and the Proposed design shall be clearly indicated.

806.5.2 Energy-related features. A list of the energy-related features that are included in the proposed design and on which compliance with the provisions of the code are claimed shall be provided to the code official. This list shall include and prominently indicate all features that differ from those set forth in Section 806.4 and used in the energy analysis between the Standard design and the Proposed design.

806.5.3 Input and output report(s). Input and output report(s) from the energy analysis simulation program containing the complete input and output files, as applicable. The output file shall include energy use totals and energy use by energy source and end-use served, total hours that space conditioning loads are not met, and any errors or warning messages generated by the simulation tool as applicable.

806.5.4 Written explanation(s). An explanation of any error or warning messages appearing in the simulation tool output shall be provided in a written, narrative format.

CHAPTER 9
REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 107.

AAMA

American Architectural Manufacturers Association
1827 Walden Office Square
Suite 104
Schaumburg, IL 60173-4628

Standard reference number	Title	Referenced in code section number
101/I.S.2—97	Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors	Table 502.1.4.1, 601.3.2.2, 802.3.1

ANSI

American National Standards Institute
25 West 43rd Street
Fourth Floor
New York, NY 10036

Standard reference number	Title	Referenced in code section number
Z21.10.3—98	Gas Water Heaters, Volume III, Circulating Tank, Instantaneous and Large Automatic Storage-Type Heaters	Table 504.2
Z21.13—91	Gas-Fired Low-Pressure Steam and Hot Water Boilers—with 1993 and 1994 Addenda	Table 803.2.2(5)
Z21.47—93	Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Furnaces) — with Addendum Z21.47a-1995 and Z21.47b-1997	Table 803.2.2(4)
Z21.56—98	Gas-Fired Pool Heaters	Table 504.2
Z83.8—96	Gas-Fired Duct Furnaces—with Addendum Z83.8a-1997	Table 803.2.2(4), Table 803.3.2(3)
Z83.9—96	Gas Unit Heaters	Table 803.2.2(4), Table 803.3.2(3)

ARI

Air Conditioning and Refrigeration Institute
4301 North Fairfax Drive
Suite 425
Arlington, VA 22203

Standard reference number	Title	Referenced in code section number
210/240—94	Unitary Air-Conditioning and Air-Source Heat Pump Equipment	Table 503.2, Table 803.2.2(1), Table 803.2.2(2)
320—93	Water Source Heat Pumps	Table 803.2.2(2)
325—93	Ground Water Source Heat Pumps	Table 803.2.2(2)
340/360—93	Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment	Table 803.2.2(1), Table 803.2.2(2)
365—94	Commercial and Industrial Unitary Air-Conditioning Condensing Units	Table 803.3.2(1)
310/380—93	Standard for Packaged Terminal Air-Conditioners and Heat Pumps	202, Table 803.2.2(3)
550/590—98	Water Chilling Packages Using the Vapor Compression Cycle	Table 803.3.2(2)

ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
55—92	Thermal Environmental Conditions for Human Occupancy	202
62—89	Ventilation for Acceptable Indoor Air Quality	202
90.1—89	Energy Efficient Design of New Buildings, Except Low Rise Residential Buildings	63.1016 Note, 63.1020

ASHRAE—continued

136—93	A Method of Determining Air Change Rates in Detached Dwellings	402.1.3.10
ASHRAE/IESNA—93	Energy Code for Commercial and High-Rise Residential Buildings — Based on ASHRAE/IES 90.1-1989—with Revisions thru October 7, 1997 including Errata and Addendum 90.1c-1993	503.1, 801.2, 802.1, 802.2
ASHRAE—97	Handbook of Fundamentals	Table 302.1, 402.3.2, 502.2.1.1.2, 502.2.2, 503.3.1, 803.2.1
ASHRAE—87	HVAC Systems and Applications Handbook	504.2.2

ASME

American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
A112.18.1M—96	Plumbing Fixture Fittings	504.6.1

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2859

Standard reference number	Title	Referenced in code section number
C 236—93	Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box	602.1.1.1
C 177—85	Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-hot-plate Apparatus	63.1018(2)(a)
C 335—84	Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation	63.1018(2)(a)
C 518—98	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	Table 503.3.3.3
C 976—96$^{\epsilon 1}$	Standard Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box	602.1.1.1
D 4099—95	Standard Specification for Poly (Vinyl Chloride) PVC Prime Windows/Sliding Glass Doors	Table 502.1.4.1
E 96—95	Standard Test Methods for Water Vapor Transmission of Materials	502.1.1, 602.1.7, 802.1.2
E 283—91	Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen	502.1.3, Table 502.1.4.1, 802.3.1
E 779—92$^{\epsilon 1}$	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	402.1.3.10

DOE

U.S. Department of Energy
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
10 CFR; Part 430, Subpart B, Appendix E—98	Uniform Test Method for Measuring the Energy Consumption of Water Heaters	Table 504.2, Table 803.2.2(4)
10 CFR; Part 430, Subpart B, Appendix N—98	Uniform Test Method for Measuring the Energy Consumption of Furnaces	Table 503.2, Table 803.2.2(5)
10 CFR; Part 430, Subpart B, Test Procedures—98	Energy Conservation Program for Consumer Products	202
DOE —88	DOE Building Foundation Design Handbook	Table 502.2, 502.2.1.5, 502.2.3.5
DOE—Current Calendar Year	DOE State-Average Energy Prices	806.2.3

HI

Hydronics Institute
35 Russo Place
P.O. Box 218
Berkley Heights, NJ 07922

Standard reference number	Title	Referenced in code section number
HI HBS 86—89	Heating Boiler Standard 86 - Testing and Rating Standard for Heating Boilers, 6th Ed.	Table 803.2.2(5)

ICC

International Code Council, Inc.
5203 Leesburg Pike, Suite 600
Falls Church, VA 22041-3401

Standard reference number	Title	Referenced in code section number
EC—2000	ICC Electrical Code™ – Administrative Provisions	202
IBC—2000	International Building Code®	202
IFC—2000	International Fire Code®	202
IFGC—2000	International Fuel Gas Code®	202
IMC—2000	International Mechanical Code®	202, 503.3.3.4, 803.2.5, 803.2.6, 803.3.4, 803.3.8.1
IPC—2000	International Plumbing Code®	202
IECC—2000	International Energy Conservation Code®	Comm 63

IESNA

Illuminating Engineering Society of North America
120 Wall Street, 17th Floor
New York, NY 10005-4001

Standard reference number	Title	Referenced in code section number
IESNA/ASHRAE—93	Energy Code for Commercial and High-Rise Residential Buildings — Based on ASHRAE/IES 90.1-1989—with Revisions thru October 7, 1997 including Errata and Addendum 90.1c-1993	503.1, 801.2, 802.1, 802.2

NCMA

National Concrete Masonry Association
2302 Horse Pen Road
Herndon, VA 20171-3499

Standard reference number	Title	Referenced in code section number
NCMA—99	Evaluation Procedures of Integrally Insulated Concrete Masonry Walls	63.1018(2)(c)

NFRC

National Fenestration Rating Council, Inc.
1300 Spring Street Park
Suite 120
Silver Spring, MD 20910

Standard reference number	Title	Referenced in code section number
100—97	Procedure for Determining Fenestration Product U-Factors	102.5.2, 601.3.2, 601.3.2.1
200—95	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidence	102.5.2, 601.3.2, 601.3.2.1

NOAA

National Oceanic and Atmospheric Administration
U.S. Department of Commerce
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
NOAA—90	Annual Degree Days to Selected Bases Derived from the 1961-1990 Normals	Table 302.1

SMACNA

Sheet Metal and Air Conditioning Contractors National Association, Inc.
4021 Lafayette Center Drive
Chantilly, VA 20151-1209

Standard reference number	Title	Referenced in code section number
SMACNA—85	HVAC Air Duct Leakage Test Manual	402.1.3.9, 503.3.3.4.1, 803.3.6

WDMA

Window and Door Manufacturers Association
1400 Touhy Avenue
Des Plaines, IL 60018

Standard reference number	Title	Referenced in code section number
101/I.S.2—97	Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors	Table 502.1.4.1, 601.3.2.2, 802.3.1

UL

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

Standard reference number	Title	Referenced in code section number
181A—94	Closure Systems for Use with Rigid Air Ducts and Air Connectors —with Revisions thru December 1994	503.3.3.4.3, 803.2.8
181B—95	Closure Systems for Use with Flexible Air Ducts and Air Connectors —with Revisions thru December 1998	503.3.3.4.3, 803.2.8
727—94	Oil-Fired Central Furnaces—with Revisions thru January 1999	Table 803.2.2(4)
731—95	Oil-Fired Unit Heaters—with Revisions thru January 1999	Table 803.2.2(4), Table 803.3.2(3)

COMM 63
SUBCHAPTER III

BUILDING DESIGN FOR COMMERCIAL BUILDINGS

PART 1
APPLICATION

Comm 63.1001 Application. This subchapter shall be applied to all commercial buildings unless the building complies with IECC chapter 8.

PART 2
DEFINITIONS

Comm 63.1005 Definitions. In this subchapter:

(1) "Ambient Lighting" is lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect. When designed for lower-than-task illuminance used in conjunction with other specific task lighting systems, it is also called "general" lighting.

(2) "Automatic" means self-acting, operating by its own mechanism when actuated by some impersonal influence, such as, a change in current strength, pressure, temperature, or mechanical configuration.

(3) "Automatic time switch control devices" means control devices that are capable of automatically turning loads off and on based on time schedules.

(4) "Building envelope" means the elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from unconditioned spaces.

(5) "Comfort cooling" or "comfort heating" means treating air to control one or more of the following: temperature, relative humidity, or distribution to meet the comfort requirements of the human occupants of the conditioned space.

(6) "Conditioned floor area" or "CFA" means the floor area in square feet of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space.

(7) "Commercial building" means a building as defined in IECC Section 202.

(8) "Conditioned space" means a cooled space, heated space, or indirectly conditioned space.

(9) "Cooled space" means an enclosed space within a building that is conditioned by a cooling system with a sensible capacity that either exceeds 5 Btu/hr sq ft or is capable of maintaining a space dry-bulb temperature of 90°F (32 °C) or less at design conditions.

(10) "Daylighting control" means a device that automatically regulates the power input to electric lighting near the fenestration to maintain the desired workplace illumination, thus taking advantage of direct or indirect sunlight.

(11) "Daylit area" means the space on the floor that is the larger of par. (a) or (b) as follows:

(a) 1. For areas daylit by vertical glazing, the daylit area has the length of 15 feet (4572 mm), or the distance on the floor, perpendicular to the glazing, to the nearest 60-inch (1524 mm) or higher opaque partition, whichever is less; and a width of the window plus either 2 feet (610 mm) on each side, the distance to an opaque partition, or one-half the distance to the closest skylight or vertical glazing, whichever is least.

2. For areas daylit by horizontal glazing, the daylit area is the footprint of the skylight plus, in each of the lateral and longitudinal dimensions of the skylight, the lesser of the floor-to-ceiling height, the distance to the nearest 60-inch (1524 mm) or higher opaque partition, or one-half the horizontal distance to the edge of the closest skylight or vertical glazing.

(b) The daylit area calculated using a method acceptable to the department.

(12) "Deadband" means the range of values within which an input variable can be varied without initiating any noticeable change in the output variable.

(13) "Degree day" means a unit based upon temperature difference and time, used in estimating annual heating or cooling energy consumption. One degree day accrues for each degree of difference between the daily mean temperature and a reference temperature.

(14) "Display lighting" means lighting confined to the area of a display that provides a higher level of illuminance than the level of surrounding ambient illuminance.

(15) "Economizer, air" means a ducting arrangement and automatic control system that allows a cooling supply fan to supply outside air to reduce or eliminate the need for mechanical refrigeration during mild or cold weather.

(16) "Economizer, water" means a system by which the supply air of a cooling system is cooled directly or indirectly or both by evaporation of water or other appropriate fluid in order to reduce or eliminate the need for mechanical refrigeration during some time periods.

(17) "Effective aperture" or "EA" means for windows, the visible light transmittance times the window wall ratio per wall; and for sky lights, the well efficiency times the visible light transmittance times the sky light area times 0.85 divided by the gross exterior roof area.

(18) "Efficacy" means the ratio of light from a lamp to the electrical power consumed, including ballast losses, expressed in lumens per watt.

(19) "Emissivity" means the ratio of the rate of radiant heat energy emitted by a body at a given temperature to the rate of radiant heat energy emitted by a standard called a blackbody, at the same temperature in the same surroundings.

(20) "Exterior envelope" has the same meaning as "building envelope."

(21) "Exterior roof or ceiling" means an exterior partition, or partition separating a conditioned space from an enclosed unconditioned space, that has a slope less than 60 degrees (1.1 rad) from horizontal, that has conditioned space below, and that is not an exterior door or skylight.

(22) "Exterior roof or ceiling area" means the area of the exterior surface of an exterior roof or ceiling.

(23) "Exterior wall" means an exterior partition that is not an exterior floor or soffit, exterior door, exterior roof or ceiling, window, or skylight.

(24) "Exterior wall area" means the area of the opaque exterior surface of exterior walls.

(25) "Fenestration" means any light-transmitting section in a building wall or roof. The fenestration includes glazing material, which may be glass or plastic, framing such as mullions, muntins, and dividers, external shading devices, internal shading devices, and integral or between glass shading devices.

(26) "Fenestration area" means the total area of fenestration measured using the rough opening and including the glazing material, sash, and frame.

(27) "General lighting" means lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect. When designed for lower-than-task illuminance used in conjunction with other specific task lighting systems, it is also called "ambient" lighting.

(28) "Gross exterior wall area" means the gross area of exterior walls separating a conditioned space from the outdoors or from unconditioned spaces as measured on the exterior above grade. It consists of the opaque wall, excluding vents and grills, including between floor spandrels, peripheral edges of flooring, window areas including sash, and door areas.

(29) "Gross floor area" means the sum of the floor areas of the conditioned spaces within the building including basements, mezzanine and intermediate-floored tiers, and penthouses of headroom height 7.5 feet (2286 mm) or greater. It is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings, excluding covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

(30) "Gross floor area over outside or unconditioned spaces" means the gross area of a floor assembly separating a conditioned space from the outdoors or from unconditioned spaces as measured from the exterior faces of exterior walls or from the center line of walls separating buildings. The floor assembly shall be considered to include all floor components through which heat may flow between indoor and outdoor or unconditioned environments.

(31) "Gross lighted area" or "GLA" means the sum of the total lighted areas of a building measured from the inside of the perimeter walls for each floor of the building.

(32) "Gross roof area" means the gross area of a roof or ceiling assembly separating a conditioned space from the outdoors or from unconditioned spaces, measured from the exterior faces of exterior walls or from the centerline of walls separating buildings. The roof assembly shall be considered to include all roof or ceiling components through which heat may flow between indoor and outdoor environments including skylights but excluding service openings.

(33) "Gross exterior roof area" means the sum of the skylight area and the exterior roof/ceiling area.

(34) "Heat capacity" or "HC" means the amount of heat necessary to raise the temperature of a given mass 1 degree. Numerically, it is the mass multiplied by the specific heat.

(35) "Heated space" means an enclosed space within a building that is conditioned by a heating system with an output capacity either exceeding 10 Btu/h · ft^2 or capable of maintaining a space dry-bulb temperature of 50°F (10°C) or more at design conditions.

(36) "Heating, ventilating, and air-conditioning system" or "HVAC system" means the equipment, distribution network, and terminals that provide either collectively or individually the process of heating, ventilating, or air conditioning to a building.

(37) "Indirectly conditioned space" means an enclosed space including, but not limited to, unconditioned volume in atria, that is not directly conditioned space; and either has an area-weighted heat transfer coefficient to directly conditioned space exceeding that to the outdoors or to unconditioned space, or is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

(38) "Informational sign" means a sign used to give building or room identification direction or a warning for safety purposes in a building, but does not include advertising signs for product or merchandise displays.

(39) "Listed space area" or "LS" means any interior space with an identified area of activities for which a light-

ing power budget is calculated and listed in the lighting power allowance determination.

(40) "Lumen maintenance control device" means a device capable of automatically adjusting the light output of a lighting system throughout a continuous range to provide a preset level of illumination.

(41) "Luminaire" means a complete lighting unit consisting of at least one lamp and the parts designed to distribute the light, to position and protect the lamp, to connect the lamp to the power supply and ballasting, when applicable. Luminaires are commonly referred to as "lighting fixtures" or "instruments."

(42) "Manual" means capable of being operated by personal intervention.

(43) "Mass wall" means a wall assembly with a heat capacity (HC) greater than or equal to 5 Btu/ft²°F.

(44) "Mass wall insulation position" means:

(a) Exterior insulation position: a wall having all or nearly all of its mass exposed to the room air with the insulation on the exterior of that mass.

(b) Integral insulation position: a wall having mass exposed to both room and outside air with substantially equal amounts of mass on the inside and outside of the insulation layer.

(c) Interior insulation position: a wall not meeting either par. (a) or (b), particularly a wall having most of its mass external to an insulation layer.

(45) "Medical and clinical care" means the promotion of the condition of being sound in body or mind through medical, dental or psychological examination and treatment.

(46) "Multiscene dimming system" means a lighting control device that has the capability of setting light levels throughout a continuous range, and that has pre-established settings within the range.

(47) "Occupant-sensing device" means a device that automatically controls the lights based on occupancy.

(48) "Opaque areas" means all exposed areas of a building envelope which enclose conditioned space except fenestration areas and building service openings such as vents and grilles.

(49) "Ornamental chandeliers" means ceiling-mounted, close-to-ceiling, or suspended decorative luminaires that use glass, crystal, ornamental metals, or other decorative material and that typically are used in hotels, motels, restaurants, or churches as a significant element in the interior architecture.

(50) "Precision commercial or industrial work" means an art, craft, or manufacturing operation requiring a certain degree of refinement.

(51) "Private driveways, walkways, and parking lots" means exterior transit areas that are associated with a commercial or residential building and intended for use solely by the employees or tenants and not by the general public.

(52) "Public driveways, walkways, and parking lots" means exterior transit areas that are intended for use by the general public.

(53) "Recooling" means lowering the temperature of air that has been previously heated by a heating system.

(54) "Recovered energy" means energy utilized from an energy-using system which would otherwise be wasted or not contribute to a desired end use.

(55) "Reduced flicker operation" means the operation of a light, in which the light has a visual flicker less than 30 percent for frequency and modulation.

(56) "Reheating" means raising the temperature of air that has been previously cooled either by refrigeration or an economizer system.

Note: Introducing outdoor air necessary to meet ventilation requirements or to assure adequate indoor air quality is not considered to be cooling.

(57) "Reset" means adjustment of the controller set point to a higher or lower value automatically or manually.

(58) "Residential building" means a building as defined in IECC Section 202.

(59) "Sconce" means a wall-mounted decorative light fixture.

(60) "Shading coefficient" or "SCx " means the ratio of solar heat gain through a fenestration, with or without integral shading devices, to that occurring through unshaded $^1/_8$-inch-thick (3 mm) clear double strength glass.

(61) "Shell building" means a building for which the envelope is designed, constructed, or both prior to knowing the occupancy type.

Note: See also "Speculative Building".

(62) "Speculative building" means a building for which the envelope is designed, constructed, or both prior to the design of the lighting, HVAC systems, or both. A speculative building differs from a shell building in that the intended occupancy is known for the speculative building.

Note: See also "Shell Building".

(63) "Support area" means an area for functions that are different from but necessary to accomplish the main activity or purpose of other listed space areas.

(64) "Tandem wired" means pairs of luminaires operating with one lamp in each luminaire powered from a single two-lamp ballast contained in the other luminaires.

(65) "Task-oriented lighting" means lighting that is designed specifically to illuminate a task location, and that is generally confined to the task location.

(66) "Thermal break" means an element of low thermal conductivity placed in an assembly to reduce the flow of heat between highly conductive materials.

(67) "Thermal conductance" or "C" means the constant time rate of heat flow through a unit area of a body induced by a unit temperature difference between the

surfaces, expressed in Btu/h·ft²°F (W/m²·K) or equivalent units. It is the reciprocal of thermal resistance.

(68) "Thermal resistance" or "*R*" means the reciprocal of thermal conductance, 1/C expressed in h · ft² · °F/Btu (m²·K/W) or equivalent units. The total thermal resistance of an assembly is $1/U_o$.

(69) "Thermal transmittance" or "*U*" means the overall coefficient of heat transfer from fluid to fluid. It is the time rate of heat flow per unit area under steady conditions from the fluid on the warm side of the barrier to the fluid on the cold side, per unit temperature difference between the two fluids, expressed in Btu/h · ft² · °F (W/m²·K) or equivalent units.

(70) "Thermal transmittance, overall" or "U_o" means the gross overall (area weighted average) coefficient of heat transfer from air to air or fluid to fluid for a gross area of the building envelope, expressed in Btu/h · ft² · °F (W/m²·K) or equivalent units. The U_o value applies to the combined effect of the time rate of heat flows through the various parallel paths such as windows, doors, and opaque construction areas comprising the gross area of one or more building envelope components such as walls, floors, and roof or ceiling.

(71) "Thermostat" means an automatic control device responsive to temperature.

(72) "Unconditioned space" means a space within a building that is not a conditioned space.

Note: See "Conditioned Space".

(73) "Unlisted space" means the difference in area between the gross lighted area and the sum of all listed space areas.

(74) "Variable air volume HVAC system" or "VAV HVAC system" means HVAC systems that control the dry-bulb temperature within a space by varying the volume of air supply to the space.

(75) "Visible light transmittance" or "VLT" means the ratio, expressed as a decimal, of visible light that is transmitted through a glazing material to the light that strikes the material.

(76) "Wall heat capacity" or "HC" means the sum of products of the mass of each individual material in the wall per unit area of wall surface times its individual specific heat, Btu/(ft²°F).

(77) "Well efficiency" means the ratio of the amount of visible light leaving a skylight well to the amount of visible light entering the skylight well and is calculated as follows:

(a) For rectangular wells:

$$\frac{\text{Well height (well length + well width)}}{2 \times \text{well length} \times \text{well width}} = \text{the well index}$$

(b) For irregular shaped wells:

$$\frac{\text{Well height (well perimeter + well width)}}{4 \times \text{well area}} = \text{the well index}$$

(c) The length, width, perimeter, and area expressed in pars. (a) and (b) are measured at the bottom of the well. The well index and the weighted average well wall reflectance are used in Figure 63.1005 to determine the well efficiency.

(78) "Window" means glazing that is not a skylight.

(79) "Window area" means the area of the surface of a window, plus the area of the frame, sash, and mullions.

(80) "Window wall ratio" means the ratio of the window area, including glazed areas of doors, to the gross exterior wall area.

(81) "Zone" means a space or group of spaces within a building with any combination of heating, cooling, or lighting requirements sufficiently similar so that desired conditions can be maintained throughout by a single controlling device.

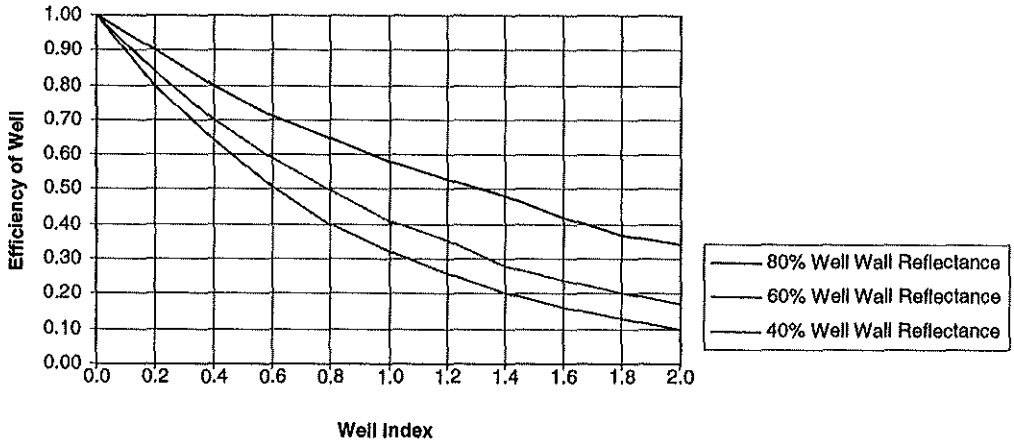

FIGURE 63.1005
WELL EFFICIENCY

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PART 3
BUILDING ENVELOPE

Comm 63.1010 Exempt buildings. This part applies to buildings or separately enclosed identifiable areas that have a mechanical space heating or air conditioning system.

Comm 63.1011 Air leakage and moisture migration.

(1) **General.** The requirements of this section apply to those building components that separate interior building conditioned space from the outdoors or from unconditioned spaces or crawl spaces. Compliance with the criteria for air leakage through building components shall be determined by tests conducted in accordance with specified standards.

(2) **Air leakage for factory-manufactured windows, doors and curtain wall assemblies.** Factory-manufactured windows, doors and curtain wall assemblies shall comply with IECC Section 802.3.1.

(3) **Air leakage requirements for exterior envelope.** Openings and penetrations in the building envelope shall be sealed or gasketed in accordance with s. Comm 63.0802 (3).

(4) **Moisture condensation.** The design of buildings shall not create conditions of accelerated deterioration from moisture condensation and shall comply with s. Comm 63.0802 (2).

Comm 63.1012 Daylight credits for skylights.

(1) **Commercial buildings.** Credits for skylights may be used in commercial buildings if the IECC Section 802 requirements and any modifications or additions specified in subch. II are met.

(2) **Residential buildings.** Daylight credits may be used in residential buildings if the IECC Section 502 requirements are met.

Comm 63.1014 Building envelope thermal performance.

(1) **General.** Except as provided in sub. (2), building envelopes shall comply with either the component standards of s. Comm 63.1015 or the system standards of s. Comm 63.1016. The calculation procedures of s. Comm 63.1019 shall be used to show compliance.

(2) **Exceptions.**

(a) Buildings and areas of buildings that are used as factories and automatic car washes shall comply with s. Comm 63.1017.

(b) Buildings and areas of buildings that are used as warehouses that have documentation provided to verify that the HVAC system to be installed does not use energy primarily to provide human comfort shall comply with s. Comm 63.1017.

Note: See s. Comm 63.1010 for exempt buildings and spaces.

Comm 63.1015 Component standards option.

(1) **General.** This section describes the component standards for building envelope thermal performance. Because component requirements consider the effect of solar gain as well as conductive heat transfer, the requirements for each component shall be met independently under this option. The wall and roof tradeoff exception in sub. (4) may be used with this option. The system analysis design method specified in IECC Section 806 shall be used to demonstrate the acceptability of tradeoffs between component energy-conserving features. Separate occupancies in the same building shall meet the requirements of this section independently.

(2) **Determination of appropriate ACP table.** The appropriate alternate component package or ACP table shall be determined based on building location using Figures 63.1015-1 and 63.1015-4.

(3) **Maximum allowable window wall ratio.** In this subsection, the percentage of windows, including glazed areas of doors, relative to the gross exterior wall area of the building shall be less than or equal to the maximum allowable window wall ratio chosen from the appropriate ACP table for the glazing type of the building. The window wall ratio is the total area of window assemblies, including glazed areas of doors, divided by the total gross exterior wall area, considering all elevations of the building. The maximum allowable window wall ratio shall be determined using the following steps:

(a) Select the shading coefficient (SCx) range that is no less than the fenestration SCx including permanently installed internal, integral and external shading devices, but excluding the effect of external shading projections. Note that this includes curtains, shades, or blinds that are permanently installed. For a shell or speculative building for which the envelope is designed or constructed prior to the design of the lighting, HVAC systems, or both, only those shading devices that are part of the design when it is being evaluated for compliance shall be considered when determining compliance.

Note: Refer to ASHRAE Handbook, Fundamentals Volume, Chapter 27 for more information on shading coefficients. Shading coefficients for fenestration may be obtained from the manufacturer or from IECC Table 102.5.2 (3) when the conversion factor for solar heat gain coefficient (SHGC) to SCx given in IECC Section 102.5.2 is applied. See also s. Comm 63.1019 (5).

(b) Select appropriate fenestration type. This is determined by the thermal transmittance value (U_{of}) of the fenestration assembly. The U_{of} of all assemblies must fall within the range, or lower, to determine the maximum window wall ratio, or an area-weighted average thermal transmittance value may be used.

(4) **Wall and roof tradeoff.** Tradeoffs between the above grade exterior wall opaque areas and the gross roof area shall be allowed if either of the following conditions are met:

(a) 1. Except as specified in subd. 2., the thermal transmittance, overall value (U_o) for any above-grade exterior opaque wall area or gross roof area may be increased or decreased, provided that the total annual energy use due to heat gain and loss for the building envelope is

less than or equal to the total annual energy use due to heat gain and loss resulting from the use of the values in the appropriate ACP table given in Figures 63.1015-1 to 63.1015-4. Calculation of the total annual energy use of the building designs shall be done in accordance with IECC Section 806.

2. The latest version of the ComCheck-EZ computer program or other programs subject to the approval of the department may be used to determine required thermal transmittance values in lieu of the ACP tables.

   Note: ComCheck-EZ is a computer program that may be used only for determining building envelope compliance. The ComCheck-EZ computer program may be downloaded at: http://www.eren.doe.gov/buildings/codes_standards/buildings/com_download.html. The federal Department of Energy has issued a computer package called ComCheck-Plus, which establishes tradeoffs between the building envelope, lighting, and HVAC equipment; however, this program has not been approved for use in Wisconsin since Wisconsin's lighting allowances are not the same as those included in the program.

   (b) A submittal to the department for review and approval, incorporating recognized engineering practices, that the annual energy use due to heat gain and loss for the building envelope shall be less than or equal to that established in par (a).

(5) Thermal transmittance values for roofs, walls and ceilings next to unconditioned spaces, and floors over unconditioned spaces.

(a) The U-values for the building roofs, walls and ceilings next to unconditioned spaces, and floors over unconditioned spaces shall be less than or equal to those listed in the appropriate ACP table given in Figures 63.1015-1 to 63.1019-4.

(b) Skylights for which daylight credit cannot be taken in accordance with s. Comm 63.1012 shall be included in the calculation of the overall thermal transmittance value of the roof assembly (U_{or}).

(c) Unconditioned below-grade spaces that have floor or ceiling assemblies insulated as specified on the appropriate ACP table do not require below-grade wall insulation.

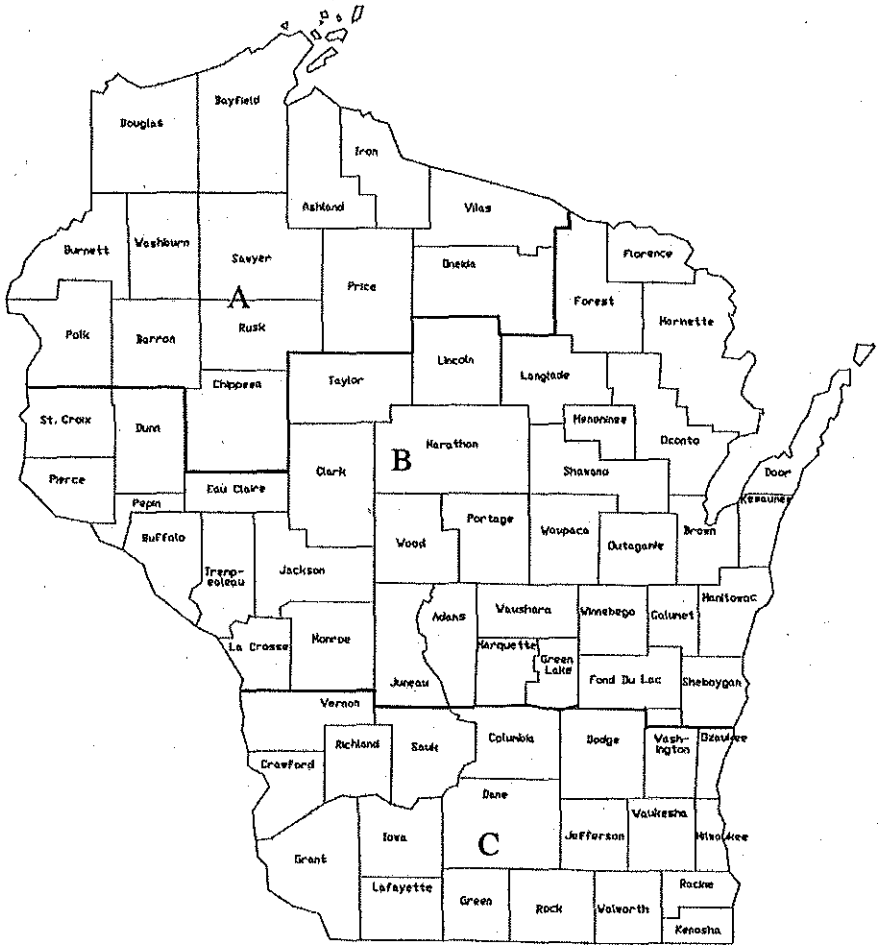


FIGURE 63.1015-1
DEGREE DAY REGIONS FOR USE WITH ACP TABLES

FIGURE 63.1015-2
ALTERNATE COMPONENT PACKAGE
ACP TABLE A

Part A1: Maximum Window Area / Gross Exterior Wall Area						
Exterior Wall U_o	Shading Coefficient Range SC_x	U_{of} Range				
		0.60 to 0.56	0.55 to 0.51	0.50 to 0.46	0.45 to 0.41	≤ 0.40
≤ 0.06	0.80 - 0.71	0.20	0.21	0.23	0.25	0.27
	0.70 - 0.61	0.20	0.22	0.24	0.26	0.28
	0.60 - 0.51	0.21	0.22	0.25	0.27	0.30
	0.50 - 0.41	0.21	0.23	0.25	0.28	0.31
	≤ 0.40	0.21	0.23	0.26	0.29	0.33
0.061 to 0.070	0.80 - 0.71	0.18	0.20	0.21	0.23	0.25
	0.70 - 0.61	0.18	0.20	0.22	0.24	0.27
	0.60 - 0.51	0.19	0.21	0.23	0.25	0.28
	0.50 - 0.41	0.19	0.21	0.23	0.26	0.30
	≤ 0.40	0.19	0.21	0.24	0.27	0.31
0.071 to 0.080	0.80 - 0.71	0.16	0.18	0.20	0.22	0.24
	0.70 - 0.61	0.17	0.18	0.20	0.23	0.25
	0.60 - 0.51	0.17	0.19	0.21	0.23	0.26
	0.50 - 0.41	0.17	0.19	0.21	0.24	0.27
	≤ 0.40	0.18	0.19	0.22	0.25	0.28
0.081 to 0.090	0.80 -0.71	0.15	0.16	0.18	0.20	0.22
	0.70 - 0.61	0.15	0.17	0.18	0.21	0.23
	0.60 - 0.51	0.15	0.17	0.19	0.21	0.24
	0.50 - 0.41	0.16	0.17	0.19	0.22	0.25
	≤ 0.40	0.16	0.17	0.20	0.22	0.26

Part A2: Other Criteria
Roof Max U_o = 0.040
Wall and Ceiling Adjacent to Unconditioned Space Max U_o = 0.10
Floor Over Unconditioned Space Max U_o = 0.040
Wall Below Grade Min R-Value = 13

Part A3: Unheated Slab-On-Grade Minimum R-Value			
Insulation	Length of insulation		
Orientation	24″	36″	48″
Horizontal	R=18	R=15	R=11
Vertical	R=8	R=6	R=4

For SI: 1 inch = 25.4 mm.

FIGURE 63.1015-3
ALTERNATE COMPONENT PACKAGE
ACP TABLE B

Part B1: Maximum Window Area / Gross Exterior Wall Area						
Exterior Wall U_o	Shading Coefficient Range SC_x	U_{of} Range				
		0.60 to 0.56	0.55 to 0.51	0.50 to 0.46	0.45 to 0.41	≤ 0.40
≤ 0.06	0.80 - 0.71	0.20	0.21	0.22	0.23	0.24
	0.70 - 0.61	0.21	0.22	0.24	0.25	0.27
	0.60 - 0.51	0.22	0.24	0.25	0.27	0.29
	0.50 - 0.41	0.24	0.25	0.27	0.30	0.32
	≤ 0.40	0.25	0.27	0.29	0.32	0.35
0.061 to 0.070	0.80 - 0.71	0.19	0.20	0.21	0.22	0.23
	0.70 - 0.61	0.20	0.21	0.22	0.24	0.25
	0.60 - 0.51	0.21	0.23	0.24	0.26	0.28
	0.50 - 0.41	0.22	0.24	0.26	0.28	0.31
	≤ 0.04	0.24	0.26	0.28	0.31	0.34
0.071 to 0.080	0.80 - 0.71	0.18	0.19	0.20	0.21	0.23
	0.70 - 0.61	0.19	0.20	0.21	0.23	0.24
	0.60 - 0.51	0.20	0.21	0.23	0.25	0.27
	0.50 - 0.41	0.21	0.23	0.25	0.27	0.29
	≤ 0.40	0.22	0.24	0.27	0.29	0.32
0.081 to 0.090	0.80 -0.71	0.17	0.18	0.19	0.20	0.21
	0.70 - 0.61	0.18	0.19	0.20	0.21	0.23
	0.60 - 0.51	0.19	0.20	0.21	0.23	0.25
	0.50 - 0.41	0.20	0.21	0.23	0.25	0.28
	≤ 0.40	0.21	0.23	0.25	0.27	0.30

Part B2: Other Criteria
Roof Max U_o = 0.045
Wall and Ceiling Adjacent to Unconditioned Space Max U_o = 0.11
Floor Over Unconditioned Space Max U_o = 0.040
Wall Below Grade Min R-Value = 12

Part B3: Unheated Slab-On-Grade Minimum R-Value			
Insulation	Length of Insulation		
Orientation	24″	36″	48″
Horizontal	R=18	R=15	R=11
Vertical	R=8	R=6	R=4

For SI: 1 inch = 25.4 mm.

FIGURE 63.1015-4
ALTERNATE COMPONENT PACKAGE
ACP TABLE C

Part C1: Maximum Window Area / Gross Exterior Wall Area						
Exterior Wall U_o	Shading Coefficient Range SC_x	U_{of} Range				
		0.60 to 0.56	0.55 to 0.51	0.50 to 0.46	0.45 to 0.41	≤ 0.40
≤ 0.06	0.80 - 0.71	0.20	0.21	0.22	0.22	0.23
	0.70 - 0.61	0.22	0.23	0.24	0.25	0.26
	0.60 - 0.51	0.23	0.25	0.26	0.27	0.29
	0.50 - 0.41	0.25	0.27	0.29	0.30	0.32
	≤ 0.40	0.27	0.29	0.32	0.34	0.37
0.061 to 0.070	0.80 - 0.71	0.19	0.20	0.21	0.22	0.23
	0.70 - 0.61	0.21	0.22	0.23	0.24	0.25
	0.60 - 0.51	0.22	0.24	0.25	0.26	0.28
	0.50 - 0.41	0.24	0.26	0.27	0.29	0.31
	≤ 0.40	0.26	0.28	0.30	0.33	0.35
0.071 to 0.080	0.80 - 0.71	0.18	0.19	0.20	0.21	0.22
	0.70 - 0.61	0.20	0.21	0.22	0.23	0.24
	0.60 - 0.51	0.21	0.23	0.25	0.26	0.27
	0.50 - 0.41	0.23	0.25	0.26	0.28	0.30
	≤ 0.40	0.25	0.27	0.29	0.31	0.34
0.081 to 0.090	0.80 -0.71	0.17	0.18	0.19	0.20	0.21
	0.70 - 0.61	0.19	0.20	0.21	0.22	0.23
	0.60 - 0.51	0.20	0.22	0.23	0.24	0.26
	0.50 - 0.41	0.22	0.23	0.25	0.27	0.29
	≤ 0.40	0.24	0.26	0.28	0.30	0.33

Part C2: Other Criteria
Roof Max U_o = 0.049
Wall and Ceiling Adjacent to Unconditioned Space Max U_o = 0.11
Floor Over Unconditioned Space Max U_o = 0.040
Wall Below Grade Min R-Value = 11

Part C3: Unheated Slab-On-Grade Minimum R-Value			
Insulation	Length of Insulation		
Orientation	24″	36″	48″
Horizontal	R=18	R=15	R=11
Vertical	R=8	R=6	R=4

For SI: 1 inch = 25.4 mm.

(6) Thermal resistance value for slab-on-grade floors.

(a) Unheated slab-on-grade floors shall have insulation around the perimeter of the floor with the thermal resistance (R_u) of the insulation as listed in the appropriate ACP table given in Figures 63.1019-1 to 63.1019-4.

(b) For heated slabs-on-grade, the required minimum *R*-value shall be the *R*-value for the unheated slab-on-grade plus 2.0.

(c) The slab insulation specified shall extend either in a vertical plane downward from the top of the slab for the minimum distance given in the appropriate ACP table or downward to the bottom of the slab then in a horizontal plane beneath the slab or outward from the building for the minimum distance given in the ACP table. Vertical insulation shall not be required to extend below the foundation footing.

(d) The *R*-value and dimensions required for slabs refer only to the building insulation materials. Insulative continuity shall be maintained in the design of slab edge insulation systems. Continuity shall be maintained from the wall insulation through the intersection of the slab, wall and footing to the body of the slab edge insulation.

Comm 63.1016 System standards option. To comply with the system standards for building envelope thermal performance, the building shall comply with section 8.6 of ASHRAE standard 90.1 or with the system analysis design specified in IECC Section 806 applied to the thermal envelope alone. Building site climate data shall be determined using Wisconsin division of state energy statistics or other source acceptable to the department.

Note: Section 8.6 of the ASHRAE 90.1 Standard requires use of the latest version of the ENVSTD computer program, which is the computer program included in the ASHRAE 90.1 Standard to evaluate an envelope tradeoff.

Note: ComCheck-EZ is a computer program that may be used only for determining building envelope compliance. The ComCheck-EZ computer program may be downloaded at: http://www.eren.doe.gov/buildings/codes_standards/buildings/com_download.html. The federal Department of Energy has issued a computer package called ComCheck-Plus, which establishes tradeoffs between the building envelope, lighting, and HVAC equipment; however, this program has not been approved for use in Wisconsin since Wisconsin's lighting allowances are not the same as those included in the program.

Comm 63.1017 Design criteria.

(1) Thermal performance.

(a) Except as provided in par. (b), the thermal performance values for the exterior envelope of buildings or areas of buildings that are warehouses that meet the criteria of s. Comm 63.1014 (2)(b), or that are factories shall not exceed the values in Table 63.1017-1. The calculation procedures of s. Comm 63.1019 shall be used to show compliance.

(b) The thermal performance values specified in par. (a) may be increased or decreased provided the *U*-value for other components is decreased or increased so the total heat gain or loss for the entire building envelope and floor area does not exceed the total heat gain or loss resulting from conformance to the values specified in this section.

TABLE 63.1017-1
THERMAL PERFORMANCE VALUES

NUMBER OF STORIES	THERMAL PERFORMANCE VALUES*
1-2	12
3-4	13
5-7	16
8-12	18
13-20	20
Over 20	21

*Expressed in Btu/hour/square foot of above-grade exterior envelope. See s. Comm 63.1023 (2) and (3) for design conditions.

(2) Floors over unconditioned spaces. The overall heat transmission coefficient (*U*-value) for floors of heated or mechanically cooled spaces over unconditioned spaces shall not exceed 0.08 Btu/h · ft² · °F.

(3) Slab-on-grade perimeter insulation. For slab-on-grade floors with or without a grade beam, a foundation bearing wall or a foundation frost wall, the thermal resistance of the insulation around the perimeter of the floor shall not be less than the values shown in Table 63.1017-2. The insulation shall extend 48 inches (1219 mm) in the vertical or horizontal direction or combination thereof with a total dimension of 48 inches (1219 mm). Slab-on-grade perimeter insulation shall be moisture resistant.

TABLE 63.1017-2
PERIMETER INSULATION REQUIREMENTS[a]

Slab-on-grade Perimeter Insulation		Zone 1	Zone 2	Zone 3	Zone 4
$R = \frac{°F \cdot ft^2 \cdot Hour}{Btu}$	Unheated Slabs	6.7	6.2	5.9	5.2
	Heated Slabs[b]	9.3	9.0	8.6	8.2

a. See Fig. 63.1023 for zone definitions.
b. Heated slabs have piping, duct work or other heat distribution system components embedded in or under them.

Comm 63.1018 Material properties.

(1) ASHRAE fundamental data. Except as specified in sub. (2), when available, information on thermal properties, performance of building envelope sections, and components and heat transfer shall be obtained from ASHRAE *Handbook of Fundamentals.*

(2) Exceptions.

(a) Laboratory or field test measurements. When the information is not available from ASHRAE *Handbook of Fundamentals*, the data may be obtained from laboratory or field-test measurements. If laboratory or field-test measurements are used for envelope heat transmission, they shall be obtained using one of the following test methods:

1. ASTM C 177, Test method by guarded hot plate apparatus.
2. ASTM C 518, Test method by means of the heat flow meter apparatus.
3. ASTM C 236, Standard test method by means of a guarded hot box.
4. ASTM C 976, Standard test method by means of a calibrated hot box.
5. ASTM C 335, Test method of horizontal pipe insulation.

(b) Foam plastic insulation. For foam plastic insulations that use a gas other than air as the insulating medium, laboratory or field tests shall be conducted on representative samples that have been aged for the equivalent of 5 years or until the *R*-value has stabilized. The tests shall be conducted by an independent third party and shall be submitted for department product review and approval in accordance with ch. Comm 61.

(c) Masonry or concrete units.

1. Integrally insulated concrete masonry systems within the scope of the National Concrete Masonry Association (NCMA) shall be evaluated for the thermal performance of the masonry or concrete units in accordance with one of the following:
   a. Use the NCMA Evaluation Procedures for the Integrally-Insulated Concrete Masonry Walls.
   b. Use of default values as approved by the department may be used. No extrapolations or interpolations are allowed.
2. All other concrete or masonry units not within the scope of the NCMA Evaluation Procedures shall comply with one of the following methods for determining the thermal performance of the assembly or system:
   a. Use default values as approved by the department. No extrapolations or interpolations are allowed.
   b. Verify thermal performance through a laboratory or field-test measurements specified in par (a).
   c. Use the department material approval process as specified in ch. Comm 61 to determine the U-factor.

Comm 63.1019 Required calculation procedures.

(1) General. The following procedures shall be used to calculate the thermal performance of above- and below-grade envelope sections of any building that is heated or mechanically cooled.

(2) Overall thermal transmittance (U_o). The overall thermal transmittance of the building envelope assembly shall be calculated in accordance with the following equation:

$$U_o = \Sigma U_i A_i / A_o = (U_1A_1 + U_2A_2 + \bullet\bullet\bullet\bullet + U_nA_n)/A_o$$

where:

U_o = The area-weighted average thermal transmittance of the gross area of an envelope assembly; that is the exterior wall assembly including fenestration and doors, the roof and ceiling assembly, and the floor assembly, Btu/h · ft² · °F.

A_o = The gross area of the envelope assembly, ft² (m²).

U_i = The thermal transmittance of each individual path of the envelope assembly, for example, the opaque portion of the wall assembly, Btu/h · ft² · °F. U_i also equals $1/R_i$ where R_i is the total resistance to heat flow of an individual path through an envelope assembly.

A_i = The area of each individual element of the envelope assembly, ft² (m²).

(3) Thermal transmittance (U_i) of an individual path through an envelope assembly. The thermal transmittance of each envelope shall be determined with consideration of all major series and parallel heat flow paths through the elements of the assembly and film coefficients. Compression of insulation shall be considered in determining the thermal resistance.

(a) Thermal transmittance of opaque elements. The thermal transmittance of opaque elements of assemblies shall be determined using a series path procedure with correction for the presence of parallel paths within an element of the envelope assembly such as wall cavities with parallel paths through insulation and studs. An acceptable procedure shall be used, as specified in Figure 63.1019-1. Figure 63.1019-2 illustrates a typical roof assembly.

FIGURE 63.1019-1
CALCULATION PROCEDURES FOR EVALUATING MAJOR SERIES AND PARALLEL HEAT FLOW PATHS

Acceptable Procedures for Determining U_i for Opaque Elements		
	Framing	
Sheathing	Metal	Nonmetal
Metal on One or Both Sides	Tests - s. Comm 63.1019 (3)(a) 1.a. Thermal Bridges - s. Comm 63.1019 (3)(a) 1.c.	Tests - s. Comm 63.1019 (3)(a) 1.a. Series or Parallel Path - s. Comm 63.1019 (3)(a) 2.
Nonmetal on Both Sides	Tests - s. Comm 63.1019 (3)(a) 1.a. Parallel Path Correction Factor - s. Comm 63.1019 (3)(a)1.b. Zone Method - s. Comm 63.1019 (3)(a)1.d.	Tests - s. Comm 63.1019 (3)(a) 1.a. Series or Parallel Path - s. Comm 63.1019 (3)(a) 2.

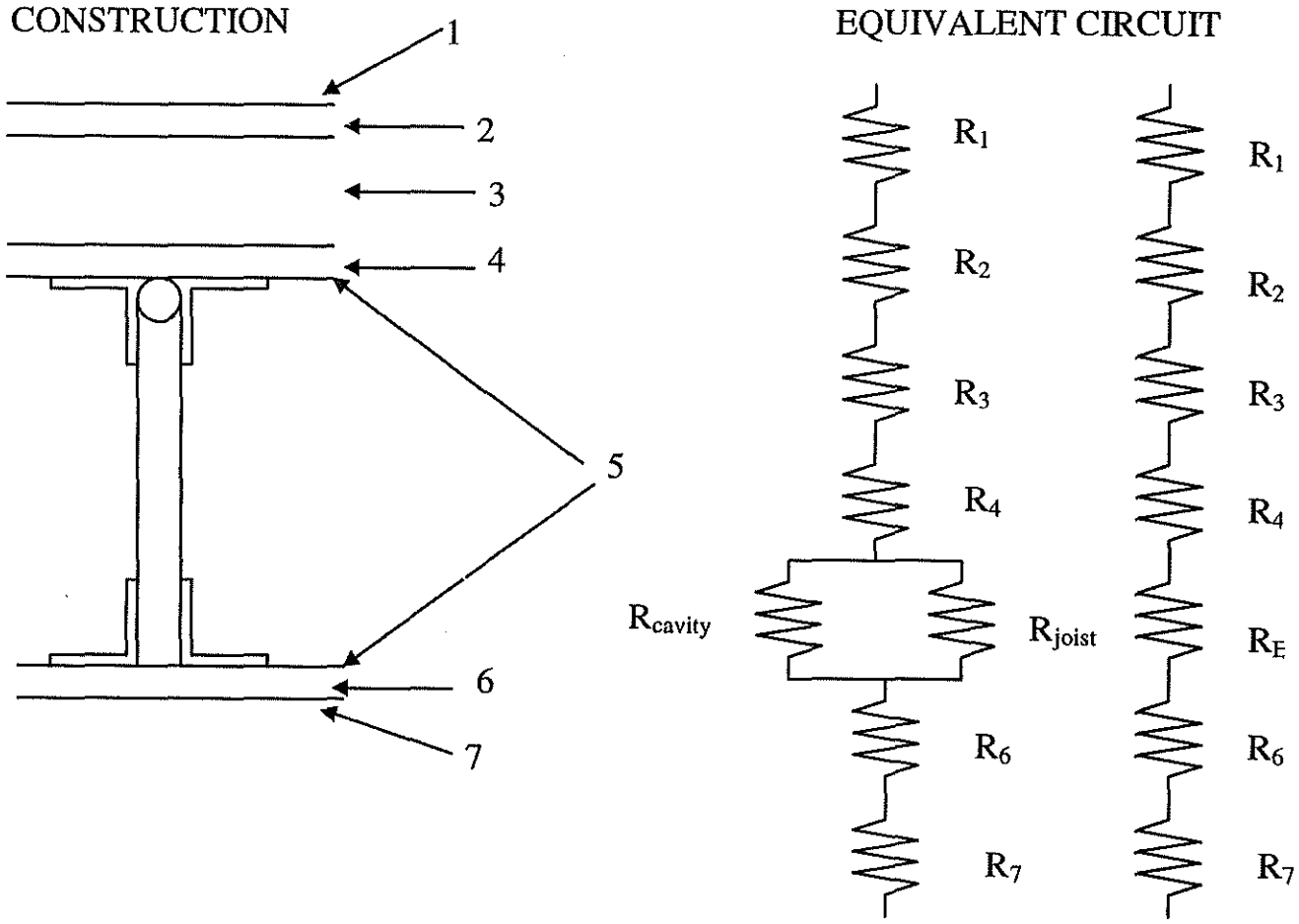


FIGURE 63.1019-2
CALCULATION PROCEDURE FOR THERMAL RESISTANCE OF A TYPICAL ROOF ASSEMBLY

Where $1/R_e = \frac{(1 - \%\ \text{joist})}{R\ \text{cavity}} + \frac{\%\ \text{joist}}{R\ \text{joist}}$ or $R_e = R\,\text{cavity} \times F_c$

R_e is the equivalent resistance of the element contacting the parallel path. F_c is the parallel path correction factor.

1. For envelope assemblies containing metal framing, the U_i shall be determined by using one of the following methods:
   a. Using results from laboratory or field-test measurements where one of the procedures specified in s. Comm 63.1018 is used.
   b. Using the thermal resistance of those roof and wall assemblies listed in Tables 63.1019-1 and 63.1019-2 shall be corrected using the following parallel path correction factor procedure:

      Considering the total resistance of the series path:

      $U_i = 1/R_t$

      $R_t = R_i + R_e$

      where:

      R_t = The total resistance of the envelope assembly.

      R_i = The resistance of the series elements (for $i = 1$ to n) excluding the parallel path element(s).

      R_e = The equivalent resistance of the element containing the parallel path, the value of R_e is:

      R_e = R-value of insulation $\times F_c$

      The Parallel Path Correction Factors (F_c) may be obtained from tests conducted using procedures listed in s. Comm 63.1018. Parallel Path Correction Factors for some envelope assemblies are listed in Tables 63.1019-1 and 63.1019-2.

   c. For elements with internal metallic structures bonded on one or both sides to a metal skin or covering, the calculation procedure specified in the ASHRAE *Handbook of Fundamentals*, or specified in ASHRAE standard 90.1, or other procedure acceptable to the department shall be used to include the effects of thermal bridges in metal construction.
   d. For elements other than those covered above, the zone method described in the ASHRAE *Handbook of Fundamentals* shall be used for calculation.

TABLE 63.1019-1
ROOFS
PARALLEL PATH CORRECTION FACTORS[a]

Bridged R-Value	0	5	10	15	20	25	30	35	40	45	50	55
Correction Factor	1.0	0.96	0.92	0.88	0.85	0.81	0.79	0.76	0.73	0.71	0.69	0.67

For SI: 1 inch = 25.4 mm.

a. Table values are based upon metal trusses with 4-foot spacing that penetrate the insulation, and 0.66-inch-diameter cross members every 1 foot.

TABLE 63.1019-2
WALL SECTIONS WITH METAL STUDS
PARALLEL PATH CORRECTION FACTORS

Size of Members	Gauge of Stud[a]	Spacing of Framing, in.	Cavity Insulation R-Value	Correction Factor	Effective Framing/Cavity R-Values
2 × 4	18-16	16 o.c.	R-11 R-13 R-15	0.50 0.46 0.43	R-5.5 R-6.0 R-6.4
2 × 4	18-16	24 o.c.	R-11 R-13 R-15	0.60 0.55 0.52	R-6.6 R-7.2 R-7.8
2 × 6	18-16	16 o.c.	R-19 R-21	0.37 0.35	R-7.1 R-7.4
2 × 6	18-16	24 o.c.	R-19 R-21	0.45 0.43	R-8.6 R-9.0
2 × 8	18-16	16 o.c.	R-25	0.31	R-7.8
2 × 8	18-16	24 o.c.	R-25	0.38	R-9.6

For SI: 1 inch = 25.4 mm.

a. These factors can be applied to metal studs of this gauge or thinner.

2. For assemblies containing nonmetal framing, the Ui shall be determined from one of the laboratory or field-test measurements specified in s. Comm 63.1018 or from the ASHRAE series-parallel method. Formulas in the ASHRAE *Handbook of Fundamentals*, shall be used for these calculations.
3. The opaque portions of doors shall be considered to be a part of the opaque wall assembly in the calculation of the average thermal transmittance. The thermal transmittance of the entire opaque door assembly including the frame shall be included in the calculation.

(b) Thermal transmittance of fenestration. Values of U_{of} shall be determined using one of the following methods:

1. The National Fenestration Rating Council (NFRC) 100 Procedure for Determining Fenestration Product U-Factors. The thermal performance values shall be certified through the NFRC Fenestration Thermal Performance Rating Certification and Labeling Program as described in the NFRC Product Certification Program LAP 1, PCP 1, and CAP 1.
2. The values for the appropriate product type given in IECC Table 102.5.2 (1) may be used.

Note: In order to use the component standards option of s. Comm 63.1015, the *U*-value of fenestration must be 0.60 or less.

(4) Gross area of envelope components.

(a) Roof assembly. The gross area of a roof assembly consists of the total surface of the roof assembly exposed to outside air or unconditioned spaces. The roof assembly shall be considered to include all roof or ceiling components through which heat may flow between indoor and outdoor environments including skylight surfaces but excluding service openings. For thermal transmittance purposes when return air ceiling plenums are employed, the roof or ceiling assembly shall not include the resistance of the ceiling or the plenum space as part of the total resistance of the assembly.

(b) Floor assembly. The gross area of a floor assembly over outside or unconditioned spaces consists of the total surface of the floor assembly exposed to outside air or unconditioned space. The floor assembly shall include all floor components through which heat may flow between indoor and outdoor or unconditioned space environments.

(c) Exterior walls. The gross area of exterior walls enclosing a heated or cooled space is measured on the exterior and consists of the opaque wall including between floor spandrels, peripheral edges of flooring, window areas including sash, and door areas, but excluding vents, grilles, and pipes.

(5) Shading coefficients. The shading coefficient (SC_x) for fenestration shall be obtained from the ASHRAE *Handbook of Fundamentals* or from manufacturer's test data or from IECC Section 102.5.2. SC_x is the shading coefficient of the fenestration including permanently installed internal and external shading devices but excluding the effect of external shading projections, which is calculated separately. The shading coefficient used for louvered shade screens shall be determined using a profile angle of 30 degrees as found in the ASHRAE *Handbook of Fundamentals*.

PART 4
EQUIPMENT AND SYSTEMS

Comm 63.1020 Minimum equipment efficiencies.

(1) Space heating or cooling equipment that is not covered by 10 CFR Part 430, Energy Conservation Program for Consumer Products, shall have a minimum efficiency at the specified rating conditions not less than the values given in ASHRAE 90.1, section 10.4.1.

(2) Equipment ratings shall be certified under a nationally recognized certification program or rating procedure or by data furnished by the equipment manufacturer to show compliance with the minimum efficiency requirements.

Note: The following certification programs are accepted by the department: Gas Appliance and Manufacturers Association (GAMA) and Air-Conditioning and Refrigeration Institute (ARI).

(3) Compliance with minimum efficiency requirements specified for HVAC equipment shall include compliance with part-load requirements where indicated as well as standards for full-load requirements. The part-load efficiency shall be determined as specified in ASHRAE 90.1.

(4) Space heating or cooling equipment used to provide additional functions, such as water heating for plumbing, as part of a combination or integrated system shall comply with minimum performance requirements for the appropriate space heating or cooling equipment category.

(5) Equipment providing water heating for plumbing that is used to provide additional functions, such as space heating, as part of a combination or integrated system shall comply with minimum performance requirements for water heating equipment as specified in s. Comm 84.20 (5) (n).

(6) Combination space and plumbing water heating equipment shall comply with IECC Section 504.2.2 and s. Comm 63.0504 (1).

Note: See ch. Comm 64 for additional requirements for combined systems.

(7) Equipment that is not used for comfort cooling or comfort heating is exempt from the energy efficiency requirements of this chapter.

Note: Omission of minimum performance requirements for certain classes of HVAC equipment does not preclude use of that equipment.

Comm 63.1021 Field-assembled equipment and components. When components, such as indoor or outdoor coils, from more than one manufacturer are used as parts of air-conditioning or heating equipment, component efficiencies shall be specified based on data provided by the component manufacturers.

Comm 63.1022 Heat pump equipment controls. Controls for heat pumps equipped with supplementary heaters that are installed in residential buildings shall comply with IECC Section 503.3.2.3, and controls for equipment installed in commercial buildings shall comply with IECC Sections 803.3.3.1.1.

Comm 63.1023 Load calculations for sizing.

(1) Calculation procedures. Heating and cooling system design loads for the purpose of sizing systems and equipment shall be determined in accordance with the procedures described in the ASHRAE *Handbook of Fundamentals*, or a similar computation procedure approved by the department. For those design parameters addressed in subs. (2) to (6), the values specified shall be used.

Note: This section does not require the installation of cooling equipment.

(2) Indoor design conditions. The winter indoor design temperature is specified in Table 64.0403. When air conditioning is provided in accordance with ch. Comm 64, the summer indoor design temperature is 78°F (25°C) or lower.

(3) Outdoor design conditions. Winter maximum and summer minimum for outdoor design temperatures shall be taken from Figure 63.1023.

Note: Systems may be designed for colder winter temperatures or for warmer summer temperatures.

(4) Ventilation. Outdoor air ventilation loads shall be based on ventilation rates specified in ch. Comm 64.

(5) Envelope. Envelope heating and cooling loads shall be based on envelope characteristics such as thermal conductance, shading coefficient, and air leakage consistent with the values used to demonstrate compliance with this subchapter, Part 3, building envelope.

(6) Lighting. Lighting loads shall be based on actual design lighting levels or power budgets consistent with subch. III, Part 5. Lighting loads may not be included for the purpose of calculating design heating loads.

Comm 63.1024 System and equipment sizing. HVAC systems and equipment shall be sized to provide the minimum space and system loads calculated in accordance with s. Comm 63.1023. Heating and cooling equipment and systems shall meet the minimum efficiencies in IECC Table 803.2.2 (1).

Comm 63.1026 Temperature controls.

(1) System control. Each HVAC system shall include at least one temperature control device.

(2) Zone controls.

(a) Individual thermostatic controls.

1. 'General.' Except as provided in subd. 2., the supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls responding to temperature within the zone.

2. 'Exceptions.' Independent perimeter systems that are designed to offset only envelope heat losses or gains, or both, may serve one or more zones also served by an interior system with the following limitations:

a. The perimeter system shall include at least one thermostatic control zone for each building exposure having exterior walls facing only one orientation for 50 contiguous feet (15 240 mm) or more; and

b. The perimeter system heating and cooling supply shall be controlled by thermostats located within the zones served by the system.

(b) Zone controls for comfort heating. Where used to control comfort heating, zone thermostatic controls shall be capable of being set locally or remotely by adjustment or selection of sensors down to 50°F (10°C) or lower.

(c) Zone controls for comfort cooling. Where used to control comfort cooling, zone thermostatic controls shall be capable of being set locally or remotely by adjustment or selection of sensors up to 85°F (29°C) or higher.

(d) Zone controls for both heating and cooling.

1. 'General.' Except as provided in subd. 2., zone thermostatic controls used to control both comfort heating and cooling shall be capable of providing a temperature range, or deadband, of at least 5°F (-15°C) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

2. 'Exceptions.'

a. Deadbands are not required for special occupancy, special usage, or required systems where deadband controls are not appropriate.

b. Deadbands are not required for buildings complying with the ASHRAE energy cost budget method under subch. III, Part 5, if, in the proposed building energy analysis, heating and cooling thermostat set-points are set to the same value between 70°F and 75°F (21°C and 24°C) inclusive and assumed to be constant throughout the year.

c. Deadbands may be omitted for thermostats that have manual changeover between heating and cooling modes.

Comm 63.1027 Zone controls.

(1) Thermostatic and humidistatic controls. Except as provided in sub. (2), zone thermostatic and humidistatic controls shall be capable of operating in sequence to supply heating and cooling energy to the zone. Such controls shall prevent any of the following:

(a) Reheating.

(b) Recooling.

(c) Mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by mechanical refrigeration or by economizer systems.

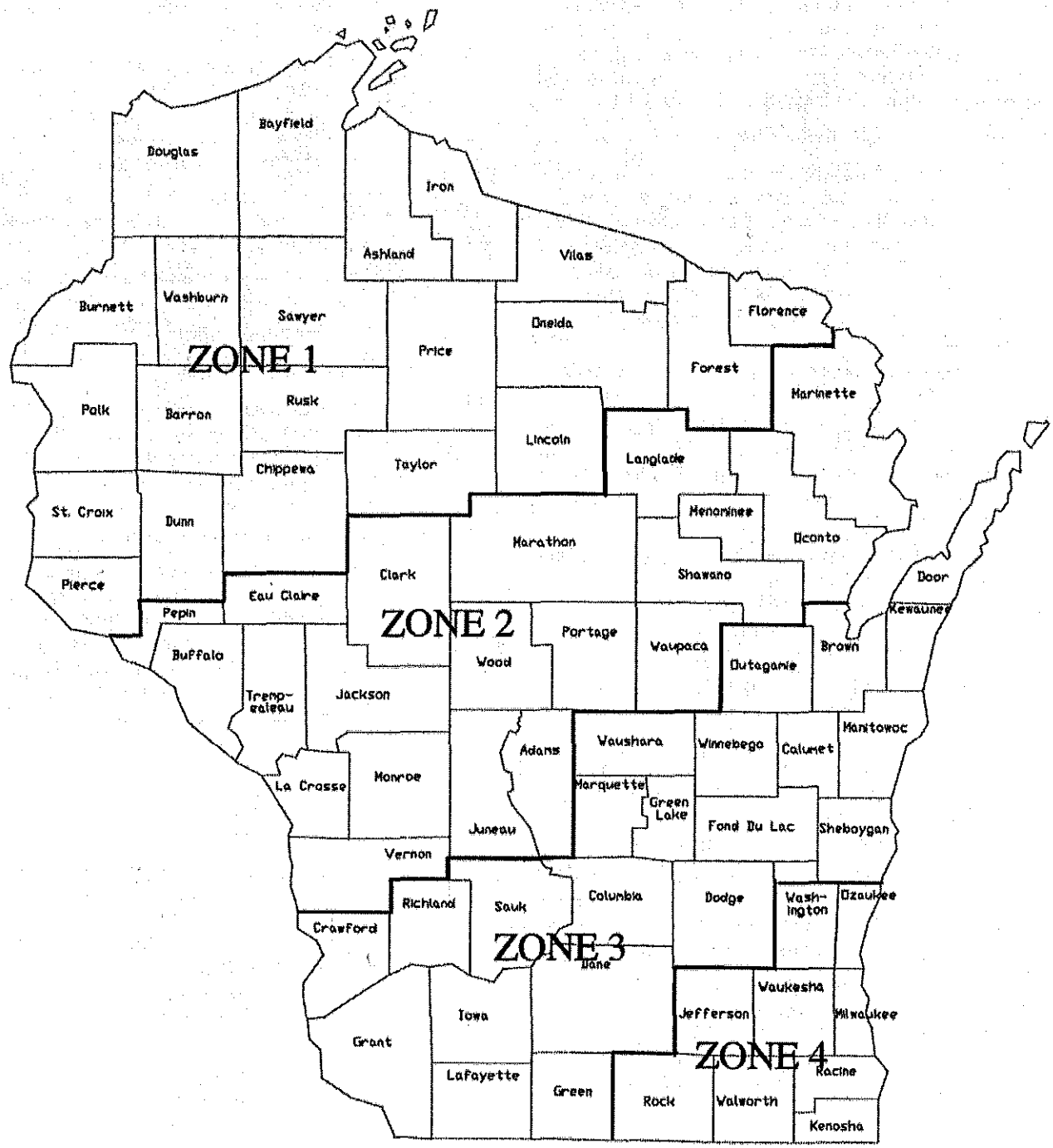


FIGURE 63.1023
OUTDOOR DESIGN CONDITIONS

Zone	Winter	Summer	
	Design Temp. (°F)	Dry Bulb (°F)	Wet Bulb (°F)
1	-25	86	75*
2	-20	87	75
3	-15	87	75
4	-10	89	77

For SI: °C = (°F-32)/1.8.
*Exception: For Douglas, Bayfield, Ashland and Iron Counties, use 70°F summer wet-bulb design temperature.

(d) Other simultaneous operation of heating and cooling systems to the same zone.

(2) Exceptions. All of the following systems and zones are exempt from this section:

(a) Variable air volume (VAV) systems which, during periods of occupancy, are designed to reduce the air supply to each zone to a minimum before reheating, recooling, or mixing takes place. This minimum volume shall be no greater than the largest of the following:

1. 30 percent of the peak supply volume.
2. The minimum required to meet ventilation requirements of ch. Comm 64.
3. 0.4 cfm/square foot of zone conditioned floor area.

(b) Zones where special pressurization relationships or cross-contamination requirements are such that VAV systems are impractical, such as isolation rooms, operating areas of hospitals, and laboratories.

(c) Where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site-solar energy source.

(d) Zones where specified humidity levels are required to satisfy process needs, such as computer rooms and museums.

(e) Zones with a peak supply air quantity of 150 cfm or less.

(f) Multiple reheat systems serving multiple zones, other than those employing variable air volume for temperature control, that are provided with controls that will automatically reset the system cold air supply to the highest temperature level that will satisfy the zone requiring the coolest air. In the case of direct expansion cooling systems, cooling may be cycled based on the zone requiring the coolest air or average room temperature for all zones.

(g) Dual duct and multizone systems that are provided with controls that will automatically reset all of the following:

1. The cold duct air supply to the highest temperature that will satisfy the zone requiring the coolest air.
2. The hot duct air supply to the lowest temperature that will satisfy the zone requiring the warmest air.

(h) Systems in which heated air is recooled, directly or indirectly, to maintain space temperature that are provided with controls that will automatically reset the temperature to which the supply air is heated to the lowest level that will satisfy the zone requiring the warmest air.

(i) A multiple-zone heating, ventilating and air-conditioning system that employs reheating or recooling for control of not more than 5,000 cfm or 20 percent of the total supply air of the system, whichever is less.

(3) Off-hour controls. Except as provided in pars. (a) to (c), mechanical HVAC systems shall be equipped with automatic controls capable of accomplishing a reduction of energy use through control setback or equipment shutdown during periods of nonuse or alternate use of the zones served by the system. The following systems are exempt from this subsection:

(a) Systems serving areas expected to operate continuously.

(b) Where it can be shown that setback or shutdown will not result in a decrease in overall building energy costs.

(c) Equipment with full load demands of 2 kW or 6826 Btu/h or less that is controlled by readily accessible manual off-hour controls.

Comm 63.1028 Humidity control. If a system is equipped with a means for adding moisture to maintain specific humidity levels in a zone or zones, a humidistat shall be provided in accordance with IECC Section 503.3.2.4 for residential buildings and IECC Section 803.2.3.2 for commercial buildings.

Comm 63.1029 Insulation, materials and construction.

(1) General. Insulation required by subs. (2) and (3) shall be suitably protected from damage. Insulation shall be installed in accordance with practices acceptable to the department. The department accepts MICA Commercial and Industrial Insulation Standards as an insulation installation practice.

(2) Piping insulation. Except as provided in pars. (a) to (c), recirculating plumbing system piping, plumbing piping in the first 8 feet from storage tanks for noncirculating systems, any piping served by a self-regulating electric heating cable, HVAC system piping, and related HVAC fluid conveying conduit, such as heat exchanger bodies, shall be thermally insulated in accordance with Table 63.1029 or equivalent. The following piping or conduit is exempted from this subsection:

(a) Factory-installed piping or conduit within HVAC equipment tested and rated in accordance with s. Comm 63.1020;

(b) Piping or conduit for which no insulation is specified in Table 63.1029.

(c) Where it can be shown that the heat gain or heat loss to or from piping or conduit without insulation will not increase building energy use.

(3) Air-handling system insulation. All air-handling ducts and plenums installed as part of an HVAC air distribution system shall be thermally insulated in accordance with s. Comm 63.0803 (2)(f).

(4) Additional duct sealing.

(a) General. Except as specified in par. (b), ductwork and plenums shall be sealed in accordance with Table 63.1029-1, and shall meet the duct seal classes specified in Table 63.1029-2.

(b) Exception. Ductwork and plenums confined within individual dwelling units shall comply with s. Comm 63.0503 (2) (c).

Comm 63.1030 Hydronic system controls. Hydronic system controls shall comply with IECC Section 803.3.3.7.

Comm 63.1031 Economizer controls.

(1) Fan system. Except as provided in sub. (2), each fan system shall be designed and capable of being controlled to take advantage of favorable weather conditions to reduce mechanical cooling requirements. The system shall include either of the following:

(a) A temperature or enthalpy air economizer system which is capable of automatically modulating outside air and return air dampers to provide 100 percent of the design supply air quantity as outside air for cooling;

(b) A water economizer system, which is capable of cooling supply air by direct evaporation, indirect evaporation, or both. Such a system shall be designed and capable of being controlled to provide 100 percent of the expected system cooling load at outside air temperatures of 50°F (10°C) dry-bulb/40°F (4°C) wet-bulb and below.

(2) Exceptions. All of the following systems are exempt from this subsection:

(a) Individual fan-cooling units with a supply capacity of less than 2,000 cfm or a total system cooling capacity of less than 62,000 Btu/hour for split systems or less than 36,000 Btu/hour for all other types. The total capacity of all such units complying by use of this exception shall not exceed 600,000 Btu/hour per building or 10 percent of the total installed cooling capacity, whichever is larger;

(b) Systems with air or evaporatively cooled condensers for which it can be shown that the use of outdoor air cooling affects the operation of other systems, such as humidification, dehumidification, or supermarket refrigeration systems, so as to increase overall building energy costs;

Note: Other areas that may use controlled humidification or dehumidification are computer rooms, museums, library stacks and drafting rooms.

(c) Where the overall building energy use resulting from alternative designs, such as internal to external zone heat recovery systems, can be shown to be less than those resulting from an economizer system.

Comm 63.1032 Electrical motors.

(1) Permanently wired motors. Any permanently wired motor that meets all of the criteria specified in pars. (a) through (g) shall meet the efficiency requirements specified in Table 63.1032 and the requirements of this section:

(a) The motor is used in a HVAC fan or pumping system.

(b) The motor is polyphase.

(c) The motor is 1 horsepower or more.

(d) The motor is a design A or B squirrel-cage, foot-mounted, T-frame induction motor that has synchronous speeds of 3,600, 1,800, 1,200, and 900 rpm.

(e) The motor is expected to operate more than 1000 hours per year.

TABLE 63.1029
PLUMBING AND HVAC PIPING MINIMUM INSULATION [in.[a] (R-Value)]

Fluid Design Operating Temp. Range, °F	Insulation Conductivity[a]		Nominal Pipe Diameter [in. (R-value)]					
	Conductivity Range Btu.in./-(h · ft² · °F)	Mean Rating Temp. °F	Runouts[b] up to 2	1 and less	1¼ to 2	2½ to 4	5 and 6	8 and up
Heating systems (Steam, Steam Condensate, and Hot Water)								
Above 350	0.32-0.34	250	1.5(R-4.4)	1.5(R-4.4)	2.5(R-7.4)	3.0(R-8.8)	3.5(R-10.3)	3.5(R-10.3)
251-350	0.29-0.31	200	1.5(R-4.8)	1.5(R-4.8)	2.5(R-8.1)	2.5(R-8.1)	3.5(R-11.3)	3.5(R-11.3)
201-250	0.27-0.30	150	1.0(R-3.3)	1.0(R-3.3)	1.5(R-5.0)	2.0(R-6.7)	2.0(R-6.7)	3.5(R-11.7)
141-200	0.25-0.29	125	0.5(R-1.8)	0.5(R-1.8)	1.5(R-5.2)	1.5(R-5.2)	1.5(R-5.2)	1.5(R-5.2)
105-140	0.24-0.28	100	0.5(R-1.8)	0.5(R-1.8)	1.0(R-3.6)	1.0(R-3.6)	1.0(R-3.6)	1.5(R-5.4)
Domestic and Service Hot Water systems[c]								
105 and greater	0.24-0.28	100	0.5(R-1.8)	1.0(R-3.6)	1.0(R-3.6)	1.5(R-5.4)	1.5(R-5.4)	1.5(R-5.4)
Cooling systems (Chilled water, brine, and refrigerant)[d]								
40-55	0.23-0.27	75	0.5(R-1.9)	0.5(R-1.9)	0.75(R-2.8)	1.0(R-3.7)	1.0(R-3.7)	1.0(R-3.7)
Below 40	0.23-0.27	75	1.0(R-3.7)	1.0(R-3.7)	1.5(R-5.6)	1.5(R-5.6)	1.5(R-5.6)	1.5(R-5.6)

For SI: °C = (°F-32)/1.8, 1 inch = 25.4 mm.

a. For insulation outside the state conductivity range, the minimum thickness (T) shall be determined as follows: $T=PR[(1+t/PR)^{K/k}-1]$, where T = minimum insulation thickness for material with conductivity K, in.; PR = actual outside radius of pipe, in.; t = insulation thickness, in.; K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature; and k = the lower value of the conductivity range listed for the applicable fluid temperature.

b. Runouts to individual terminal units not exceeding 12 ft. in length.

c. Applies to recirculating sections of service or domestic hot water systems and first 8 ft. from storage tank for nonrecirculating systems.

d. The required minimum thickness does not consider water vapor transmission and condensation.

TABLE 63.1029-1
MINIMUM DUCT SEAL LEVEL[a]

DUCT LOCATION	DUCT TYPE			
	Supply		Exhaust	Return
	≤ 2 in. w.c.[b] (500 Pa)	> 2 in. w.c.[b] (500 Pa)		
Outdoors[c]	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces	C	B	B	C

a. See Table Comm 63.0803-2 definition of Seal Class.
b. Duct design static pressure classification.
c. Includes indirectly conditioned spaces, such as return air plenums.

TABLE 63.1029-2
DUCT SEAL CLASSES

DUCT SEAL CLASS	SEALING REQUIREMENTS[a]
A	All transverse joints, longitudinal seams, and duct wall penetrations. Pressure-sensitive tape shall not be used as the primary sealant.
B	All transverse joints and longitudinal seams. Pressure-sensitive tape shall not be used as the primary sealant.
C	Transverse joints only.

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

(f) The motor is not a multispeed motor used in a system designed to use more than one speed.

(g) The motor is not a component of equipment that meets the efficiency requirements of s. Comm 63.1020 where motor input is included in the determination of the equipment efficiency.

(2) Motor nameplate. The motor nameplate shall list the minimum nominal full-load motor efficiency.

Note: Motors that are classified as "energy efficient" under the National Electric Manufacturer's Association Standard MG 12.55, dated 3-14-91, are acceptable to the department as meeting the efficiency requirements of this section.

PART 5
LIGHTING POWER

Comm 63.1040 Scope.

(1) General. Except as specified in sub. (2), sections Comm 63.1041 to 63.1051 shall apply to all of the following rooms, spaces and areas:

(a) Interior spaces of buildings.

(b) Building exteriors and exterior areas such as entrances, exits, and loading docks.

(c) Roads, grounds, parking, and other exterior areas where lighting is energized through the building electrical service.

(2) Exceptions. Lighting that is specifically designated as required by a health or life safety regulation is exempt.

Comm 63.1041 Exterior lighting power requirement. The exterior lighting power of a building or a group of buildings in a multibuilding facility calculated in accordance with s. Comm 63.1042 shall be no greater than the lighting power allowance calculated in accordance with s. Comm 63.1043.

Comm 63.1042 Calculation of exterior lighting power. The calculated exterior lighting power is the sum of the power for all exterior luminaires that are included in s. Comm 63.1040, minus the power for exempted exterior lighting as specified in subs. (1) to (5).

(1) Task lighting for outdoor activities such as manufacturing and processing facilities.

(2) Lighting power for theatrical productions.

(3) Lighting for outdoor sporting facilities, including playing and seating areas.

(4) Lighting for dwelling units that is controlled within the dwelling unit.

(5) Exit way or egress lighting required by s. Comm 73.21 that has switching regulated by Article 700 of the *National Electrical Code.*

Comm 63.1043 Exterior lighting power allowance.

(1) Calculation method. The exterior lighting power allowance for a building or a multibuilding facility is the sum of all the allowed lighting powers for all exterior areas. The lighting power for each area is calculated by multiplying the unit power allowance from Table 63.1043 by the applicable length or area.

(2) Applicable areas and lengths. The applicable areas and lengths used with Table 63.1043 to calculate the exterior lighting power allowance are described in pars. (a) to (d).

(a) Horizontal areas of grounds, driveways, lots, gardens or parks may be calculated as if they were flat, or the actual area of the surfaces of contours may be used.

TABLE 63.1032
MINIMUM ACCEPTABLE NOMINAL FULL-LOAD MOTOR EFFICIENCY FOR SINGLE-SPEED POLYPHASE SQUIRREL-CAGE INDUCTION MOTORS HAVING SYNCHRONOUS SPEEDS OF 3,600, 1,800, 1,200 AND 900 RPM

Full-Load Efficiencies—Open Motors								
	2-Pole		4-Pole		6-Pole		8-Pole	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	—	—	82.5	81.5	80.0	78.5	74.0	72.0
1.5	82.5	81.5	84.0	82.5	84.0	82.5	75.5	74.0
2.0	84.0	82.5	84.0	82.5	85.5	84.0	85.5	84.0
3.0	84.0	82.5	86.5	85.5	86.5	85.5	86.5	85.5
5.0	85.5	84.0	87.5	86.5	87.5	86.5	87.5	86.0
7.5	87.5	86.5	88.5	87.5	88.5	87.5	88.5	87.5
10.0	88.5	87.5	89.5	88.5	90.2	89.5	89.5	88.5
15.0	89.5	88.5	91.0	90.2	90.2	89.5	89.5	88.5
20.0	90.5	89.5	91.0	90.2	91.0	90.2	90.2	89.5
25.0	91.0	90.2	91.7	91.0	91.7	91.0	90.2	89.5
30.0	91.0	90.2	92.4	91.7	92.4	91.7	91.0	90.2
40.0	91.7	91.0	93.0	92.4	93.0	92.4	91.0	90.2
50.0	92.4	91.7	93.0	92.4	93.0	92.4	91.7	91.0
60.0	93.0	92.4	93.6	93.0	93.6	93.0	92.4	91.7
75.0	93.0	92.4	94.1	93.6	93.6	93.0	93.6	93.0
100.0	93.0	92.4	94.1	93.6	94.1	93.6	93.6	93.0
125.0	93.6	93.0	94.5	94.1	94.1	93.6	93.6	93.0
150.0	93.6	93.0	95.0	94.5	94.5	94.1	93.6	93.0
200.0	94.5	94.1	95.0	94.5	94.5	94.1	93.6	93.0
Full-Load Efficiencies—Enclosed Motors								
	2-Pole		4-Pole		6-Pole		8-Pole	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1.0	75.5	74.0	82.5	81.5	80.0	78.5	74.0	72.0
1.5	82.5	81.5	84.0	82.5	85.5	84.0	77.0	75.5
2.0	84.0	82.5	84.0	82.5	86.5	85.5	82.5	81.5
3.0	85.5	84.0	87.5	86.5	87.5	86.5	84.0	82.5
5.0	87.5	86.5	87.5	86.5	87.5	86.5	85.5	84.0
7.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	84.0
10.0	89.5	88.5	89.5	88.5	89.5	88.5	88.5	87.5
15.0	90.2	89.5	91.0	90.2	90.2	89.5	88.5	87.5
20.0	90.2	89.5	91.0	90.2	90.2	89.5	89.5	88.5
25.0	91.0	90.2	92.4	91.7	91.7	91.0	89.5	88.5
30.0	91.0	90.2	92.4	91.7	91.7	91.0	91.0	90.2
40.0	91.7	91.0	93.0	92.4	93.0	92.4	91.0	90.2
50.0	92.4	91.7	93.0	92.4	93.0	92.4	91.7	91.0
60.0	93.0	92.4	93.6	93.0	93.6	93.0	91.7	91.0
75.0	93.0	92.4	94.1	93.6	93.6	93.0	93.0	92.4
100.0	93.6	93.0	94.5	94.1	94.1	93.6	93.0	92.4
125.0	94.5	94.1	94.5	94.1	94.1	93.6	93.6	93.0
150.0	94.5	94.1	95.0	94.5	95.0	94.5	93.6	93.0
200.0	95.0	94.5	95.0	94.5	95.0	94.5	94.1	93.6

(b) Canopied areas are the area of the horizontal surface under the canopy. A canopy includes an exterior awning, soffit or ornamental or functional structure signifying a main entrance to a building.

(c) The linear length of door openings is measured in plan view and includes the door opening only. Sidelights and other portions of the door, which do not open, are not included.

(d) The applicable area of the building facade includes all vertical and horizontal areas that are intended to be illuminated.

TABLE 63.1043
EXTERIOR LIGHTING UNIT POWER ALLOWANCES

Area Description	Allowances
Canopies (not associated with an entrance)	4 W/ft²
Commerce or merchandizing areas	4 W/ft²
Exit (with or without canopy)	16 W/lin ft of door opening
Entrance (without canopy)	20 W/lin ft of door opening
Entrance (with canopy)	
High traffic (retail, hotel, airport, theater, etc.)	6.6 W/ft² of canopied area
Light traffic (hospital, office, school, etc.)	2.6 W/ft² of canopied area
Loading area	0.26 W/ft²
Loading door	13 W/lin ft of door opening
Building exterior surfaces/facades	0.16 W/ft² of surface area to be illuminated
Storage and nonmanufacturing work areas	0.13 W/ft²
Other activity areas for casual use such as picnic grounds, gardens, parks and other landscaped areas	0.06 W/ft²
Private driveways/walkways	0.06 W/ft²
Public driveways/walkways	0.10 W/ft²
Private parking lots	0.08 W/ft²
Public parking lots	0.12 W/ft²
Pump island canopies	4 W/ft²

Comm 63.1044 Interior lighting power requirement. The interior lighting power of a building calculated in accordance with s. Comm 63.1045 shall be no greater than the interior lighting power allowance calculated in accordance with s. Comm 63.1046.

Comm 63.1045 Calculation of interior lighting power. The calculated interior lighting power of a building is the total watts of all interior luminares including, but not limited to, track and flexible lighting systems, lighting that is integral with modular furniture, movable displays and cabinets, and internally illuminated case work for task or display purposes, minus any adjustments allowed under subs. (1) through (4).

(1) **Multiple interlocked lighting systems serving a space.** When multiple interlocked lighting systems serve a space, the watts of all systems except the system with the highest wattage may be excluded from the calculated lighting power if:

(a) The lighting systems are interlocked to prevent simultaneous operation; or

(b) The lighting systems are controlled by a preset dimming system or other device that prevents simultaneous operation of more than one lighting system, except under the direct control of authorized personnel.

(2) **Reduction of wattage through controls.** The watts of any luminaire that is controlled may be reduced by the number of watts times the applicable power adjustment factor from Table 63.1045 if all of the following are met:

(a) The control complies with s. Comm 63.1051.

(b) At least 50 percent of the light output of the luminaire is within the applicable space listed in Table 63.1045.

(c) Except as noted in Table 63.1045, only one power adjustment factor is used for the luminaire.

(d) For daylighting control credits, the luminaire is controlled by the daylighting control, and the luminaire is located within the daylit area.

(e) For automatic time switch control devices, a timed manual override is provided at each switch location required by s. Comm 63.1050. The override device shall control only the lights in the surrounding area enclosed by ceiling-height partitions.

(3) **Lighting wattage excluded.** The watts of the following lighting applications may be excluded from the calculated interior lighting power of the building.

(a) Lighting for theatrical productions and other live performances, television broadcasting, audio-visual presentations, and those portions of entertainment facilities such as stage areas in hotel ballrooms, night clubs, dance floors, churches, and casinos where lighting is an essential technical element for the function performed, if the lighting is an addition to a general lighting system, and if the lighting is separately controlled and accessible only to authorized operators.

(b) Lighting for television, video and film production.

(c) Lighting for photographic processes.

(d) Lighting for the amusement and attraction areas in theme parks.

(e) Lighting for exhibits in areas such as exhibit, convention, and hotel function areas, if the lighting is an addition to a general lighting system, and if the lighting is separately controlled and accessible only to authorized operators.

(f) Specialized local lighting installed in nonlighting process equipment by its manufacturer used to illuminate process-related tasks only.

(g) In buildings for medical and clinical care, examination and surgical lights, low-level night lights, and lighting integral to medical equipment.

(h) Lighting fixtures that are an integral part of refrigeration equipment.

TABLE 63.1045
LIGHTING POWER ADJUSTMENT FACTORS

Type of Control	Type of Space	Factor
Automatic daylighting controls Continuous dimming Multiple step dimming On/off	Daylit areas	 0.30 0.20 0.10
Automatic time switch control device in conjunction with automatic daylighting controls Continuous dimming Multiple step dimming On/off	Daylit areas ≤250 square feet	 0.35 0.25 0.15
Automatic time switch control device in conjunction with lumen maintenance and automatic daylighting controls Continuous dimming Multiple step dimming On/off	Daylit areas ≤250 square feet	 0.40 0.30 0.20
Lumen maintenance	Any space	0.10
Lumen maintenance in conjunction with an automatic time switch control device	Spaces ≤250 square feet	0.15
Automatic time switch control device	Spaces ≤250 square feet	0.15
Occupant-sensing device with a separate sensor for each space	Spaces ≤ 250 square feet enclosed by opaque floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room	0.30*
Occupant-sensing device with separate sensor for each space	Rooms of any size that are used exclusively for storage	0.60*
Occupant-sensing device with separate sensor for each space	Spaces > 250 square feet	0.10*
Occupant-sensing device with a separate sensor for each space used in conjunction with daylighting controls and separate sensor for each space Continuous dimming Multiple step dimming On/off	Spaces ≤ 250 square feet within a daylit area and enclosed by opaque floor-to-ceiling partitions	 0.40* 0.35* 0.35*
Occupant-sensing device with a separate sensor for each space used in conjunction with daylighting controls and separate sensor for each space and lumen maintenance Continuous dimming Multiple step dimming On/off	Spaces ≤ 250 square feet within a daylit area and enclosed by opaque floor-to-ceiling partitions	0.35* 0.45* 0.40* 0.35*
Occupant-sensing device with a separate sensor for each space used with lumen maintenance	Spaces ≤ 250 square feet and enclosed by opaque floor-to-ceiling partitions	0.35*
Occupant-sensing device with a separate sensor for each space used in conjunction with an automatic time switch control device	Spaces ≤ 250 square feet enclosed by opaque floor-to-ceiling partitions	0.35*
Manual dimming system	Hotels, motels, restaurants, auditoriums, theaters	0.10
Multiscene programmable dimming system	Hotels, motels, restaurants, auditoriums, theaters	0.20
Occupant-sensing device with programmable multiscene dimming system	Hotels, motels, restaurants, auditoriums, theaters	0.35

For SI: 1 square foot = 0.0929m^2.

***Note to Table 63.1045:** Adjustment factors for occupant-sensing devices are for devices with on-off operation. If devices are used that turn lights down, rather than off, the adjustment factor shall be multiplied by the percent of energy savings that occur while the lights are turned down.

(i) Nonretail display lighting required for art exhibits or displays in galleries, museums and monuments.

(j) Special lighting needed for research.

(k) Task lighting for plant growth or maintenance, if it is equipped with an automatic 24-hour time switch that has program back-up capabilities that prevent the loss of the switch's program and time setting for at least 10 hours if power is interrupted.

(l) Exit way or egress illumination that is normally off.

(m) Task lighting specifically designed for primary use by visually impaired, for lip reading, and by senior citizens.

(n) Lighting for informational signs and exit signs, but excluding commercial displays.

Note: See s. Comm 63.1005 (38) for definition of informational sign and s. Comm 63.1052 for exit sign requirements.

(o) Display window lighting in retail facilities provided the display area is separated from the store sales area by opaque ceiling-height partitions.

(p) Lighting in dwelling units that provides complete independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking, and sanitation.

(q) In restaurant buildings and areas, lighting for food warming or integral to food preparation equipment.

(r) Lighting equipment that is for sale.

(s) Lighting demonstration equipment in lighting education facilities.

(4) Lighting fixtures that allow substitution of sources. The watts of track and other lighting fixtures that allow the substitution of low-efficacy sources for high-efficacy sources without altering the wiring of the fixture shall be determined by this subsection or other method approved by the department.

(a) Track and busway line-voltage lighting. The wattage of line-voltage lighting track and plug-in busway that allow the addition and relocation, or both, of luminaries without altering the wiring of the system shall be the specified wattage of the luminaries included in the system with a minimum of 30 W/lin ft.

(b) Low-voltage lighting systems. The wattage of low-voltage lighting track, cable conductor, rail conductor, and other flexible lighting systems that allow the addition or relocation, or both, without altering the wiring of the system shall be the specified wattage of the transformer supplying the system.

(c) Incandescent medium base sockets. The wattage for medium base fixtures shall be the listed lighting power capacity, in watts, of the fixture.

Comm 63.1046 Calculation of interior lighting power allowance. The interior lighting power allowance shall be calculated using one of the methods in s. Comm 63.1047, 63.1048, or 63.1049 as applicable.

Comm 63.1047 Complete building method. The complete building method may be used only on projects involving entire buildings where at least 80 percent of the areas of the building are the same type of use. Under this approach, the interior lighting power allowance is the lighting power density value in Table 63.1047 times the floor area of the entire building. Hotel, motel and residential buildings shall not use this method. Building uses that are not listed in Table 63.1047 shall be assigned the allowed lighting power density given under "All Others."

TABLE 63.1047
COMPLETE BUILDING METHOD—
LIGHTING POWER DENSITY VALUES (Watts/ft²)

TYPE OF USE	ALLOWED LIGHTING POWER DENSITY
Banks and Financial Institutions	1.7
Correctional Housing	1.4
General Commercial and Industrial Work Buildings	1.2
Grocery Store	1.8
Industrial and Commercial Storage Buildings	0.8
Medical Buildings and Clinics	1.5
Office Building	1.5
Religious Worship, Auditorium, and Convention Centers	2.0
Restaurants	1.5
Retail and Wholesale Store	2.6
Schools	1.8
Theaters	1.5
All Others	0.8

Comm 63.1048 Area category method. Under the area category method, the interior lighting power allowance for the building is the sum of all allowed lighting powers for all areas in the building. The allowed lighting power for an area is the lighting power density in Table 63.1048 times the area. For purposes of the Area Category Method, an "Area" means all contiguous spaces that accommodate or are associated with a single one of the primary functions listed in Table 63.1048. Buildings with primary functions not listed in Table 63.1048 shall not use this method. Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall not be included in any area. The area shall not include enclosed retail display windows with exempted lighting as described in s. Comm 63.1045 (3) (o). When the Area Category Method is used to calculate the interior lighting power allowance for an entire building, main entry lobbies, corridors, rest rooms, and support functions shall be treated as separate areas.

Comm 63.1049 Activity method. Under the activity method, the interior lighting power allowance for a building is determined by calculating a lighting power budget for each space in accordance with subs. (1) to (4) and summing them in accordance with sub. (5).

(1) The lighting power budget of each interior space shall be determined in accordance with the following equation:

$$LPB = A \times UPD \times AF$$

where:
LPB = lighting power budget of the space, W
A = area of the space, ft² (m²)
UPD = unit power density, W/ft² [Table 63.1049]
AF = area factor of the room [Figure 63.1049]

(a) The *UPD* shall be selected from Table 63.1049. For applications to areas or activities other than those given, select values for the most similar areas or activities. The *UPD* for a multifunctional space shall be based on the lowest *UPD* of any of the activities of the space.

TABLE 63.1048
AREA CATEGORY METHOD —
LIGHTING POWER DENSITY VALUES (Watts/ft²)

PRIMARY FUNCTION	ALLOWED LIGHTING POWER DENSITY
Auditorium	2.0
Auto Repair	2.0
Bank/Financial Institution	1.8
Classrooms	2.0
Convention, Conference and Meeting Centers	1.6
Corridors, Rest Rooms and Support Areas	0.8
Detention Facilities	1.6
Dining	1.2
Exhibit	2.3
Storage Garage	0.2
General Commercial and Industrial Work	1.3
Grocery	2.0
Guestroom or Dorm Room	1.4
Hotel Function	2.3*
Industrial and Commercial Storage	0.6
Kitchen	2.2
Laboratory	3.3
Lobbies:	
Hotel Lobby	2.3*
Main Entry Lobby	1.6*
Malls, Arcades, and Atria	1.2*
Medical and Clinical Care	1.8
Office	1.6
Precision Commercial and/or Industrial Work	2.0
Religious Worship	2.2*
Retail Sales, Wholesale Showrooms	2.8
Theaters	
Motion Picture	1.0
Performance	1.5*

* **Note to Table 63.1048:** The smallest of the following values may be added to the allowed lighting power listed in Table 63.1048 for ornamental chandeliers and sconces that are switched or dimmed on circuits different from the circuits for general lighting:

a. 1 watt per square foot times the area of the space in which the chandelier or sconce is used; or

b. The actual design wattage of the chandelier or sconce.

(b) The area factor (*AF*) shall be determined from Figure 63.1049 based on the room area (A_r) and ceiling height. The room area shall be calculated from the inside dimensions of the room. Rooms of identical ceiling height and activities may be evaluated as a group. The AF of a group of rooms shall be determined from the average area of these rooms.

The following equation gives the formula used in developing Fig. 63.1049.

$$AF = 0.2 + 0.8(1/0.9^n)$$

where:

$$n = \left[\frac{10.21(CH - 2.5)}{\sqrt{A_r}}\right] - 1$$

AF = Area factor
CH = Average ceiling height, ft. (mm)
A_r = Room area, ft² (m²)
If $AF < 1.0$, then $AF = 1.0$
If $AF > 1.8$, then $AF = 1.8$

(2) For rooms serving multiple functions such as hotel banquet or meeting rooms and office conference or presentation rooms; an adjustment factor of 1.5 times the *UPD* may be used if a supplementary system is actually installed and meets all of the following conditions:

(a) The installed power for the supplementary system shall not be greater than 33 percent of the adjusted lighting power budget calculated for that space.

(b) Independent controls shall be installed for the supplementary system.

(3) In rooms containing multiple simultaneous activities, such as a large general office having separate accounting and drafting areas within the same room, the lighting power budget for the rooms shall be the weighted average of the activities in proportion to the areas being served.

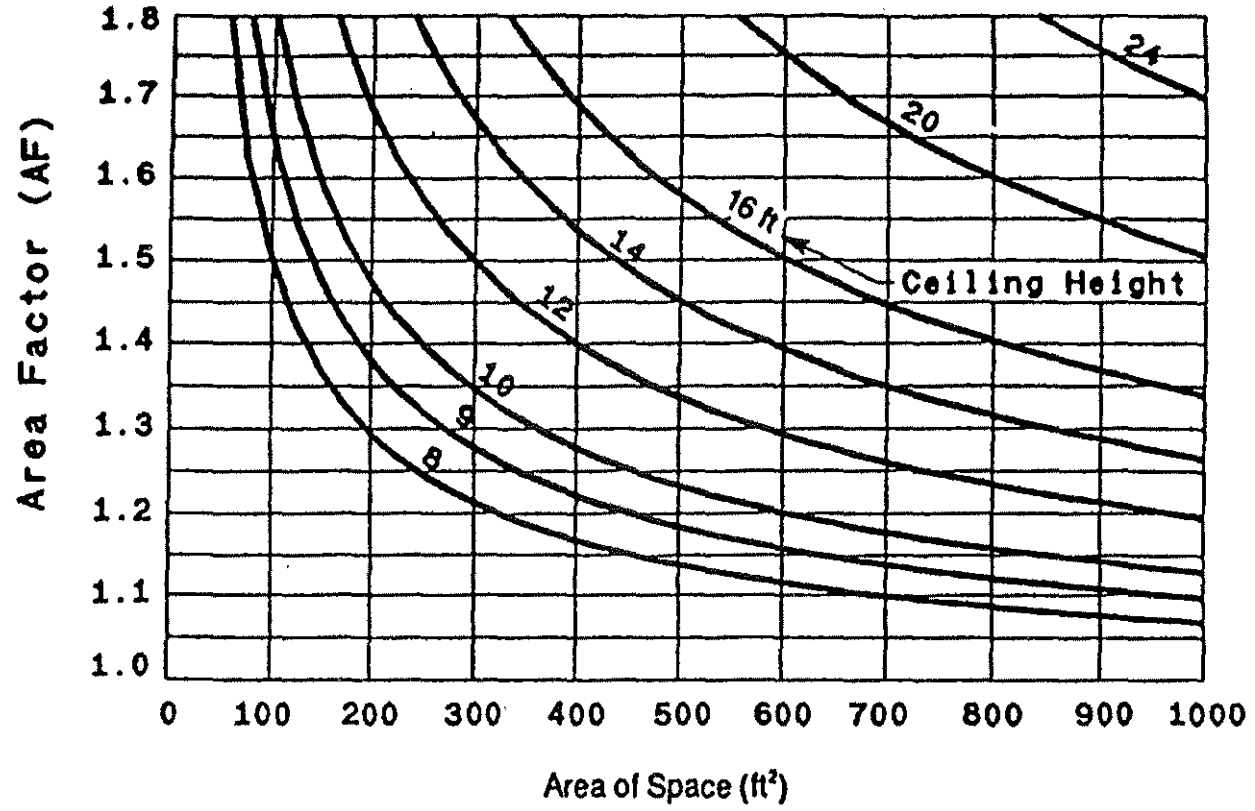
(4) The activity of indoor sports areas shall be considered as an area 10 feet (3048 mm) beyond the playing boundaries of the sport, not to exceed the total floor area of the indoor sports space less the spectator seating area.

(5) The interior lighting power allowance shall be calculated in accordance with the following equation. The interior lighting power allowance shall include a 0.20 W/ft² allowance for unlisted spaces.

$$ILPA = (LPB_1 + LPB_2 + \ldots + LPB_n) + (0.20\ \text{W/ft}^2 \times \text{unlisted space area})$$

where:

$ILPA$ = interior lighting power allowance, W
Unlisted space area = $GLA - \Sigma\ (LS)$, ft² (m²)
GLA = gross lighted area, ft² (m²)
LPB = lighting power budget, W
LS = listed space



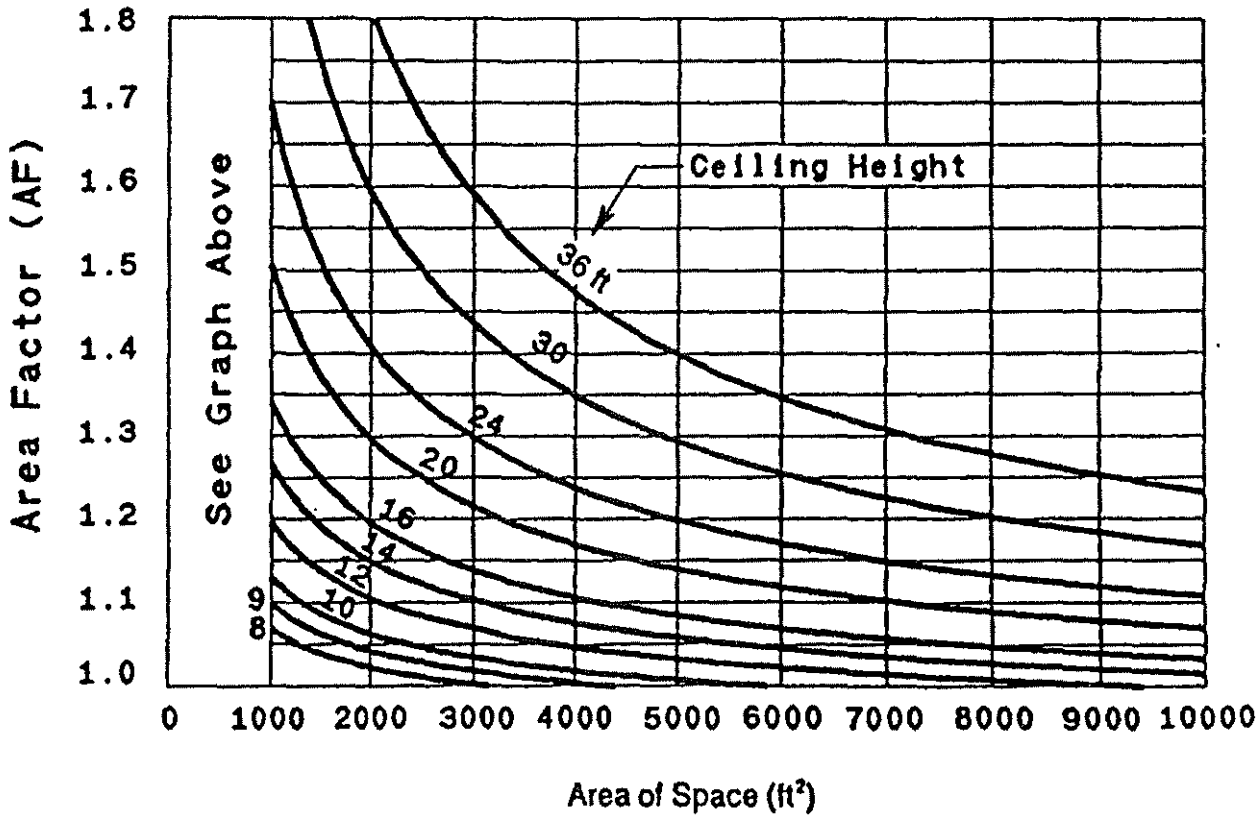


FIGURE 63.1049
AREA FACTOR

TABLE 63.1049
UNIT POWER DENSITIES

PART A — COMMON ACTIVITY AREAS		
Activity/Area	UPD W/ft^2	Note
Auditorium	1.6	a
Corridor	0.8	b
Classroom/Lecture Hall	2.0	
Electrical/Mechanical Equipment Room		
General	0.7	b
Control Rooms	1.5	b
Food Service		
Fast Food/Cafeteria	1.3	
Leisure Dining	2.5	c
Bar Lounge	2.5	c
Kitchen	1.4	
Recreation/Lounge	0.7	
Stair		
Active Traffic	0.6	
Emergency Exit	0.4	
Toilet and Washroom	0.8	
Garage		
Auto and Pedestrian Circulation Area	0.3	
Parking Area	0.2	
Laboratory	3.0	
Library		
Audio/Visual	1.1	
Stack Area	1.5	
Card File and Cataloging	1.6	
Reading Area	1.9	
Lobby (General)		
Reception and Waiting	1.0	
Elevator Lobbies	0.8	
Atrium (Multistory)		
First Three Floors	0.7	
Each Additional Floor	0.2	
Locker Room and Shower	0.8	
Office Category 1 (Enclosed offices, all open plan offices without partitions or with partitions* lower than 4.5 feet below the ceiling)		
Reading, Typing and Filing	1.8	d
Drafting	2.6	d
Accounting	2.1	d
Office Category 2 (Open plan offices 900 square feet or larger with partitions* 3.5 to 4.5 feet below the ceiling. Offices less than 900 square feet shall use Category 1)		
Reading, Typing and Filing	1.9	b
Drafting	2.9	b
Accounting	2.4	b

(continued)

TABLE 63.1049—continued
UNIT POWER DENSITIES

PART A — COMMON ACTIVITY AREAS—continued		
Activity/Area	UPD W/ft^2	Note
Office Category 3 (Open plan offices 900 square feet or larger with partitions* higher than 3.5 feet below the ceiling. Offices less than 900 square feet shall use Category 1)		
Reading, Typing and Filing	2.2	b
Drafting	3.4	b
Accounting	2.7	b
Common Activity Areas		
Conference Meeting Room	1.8	a
Computer Office Equipment	2.1	
Filing, Inactive	1.0	
Mail Room	1.8	
Shop		
Machinery	2.5	
Electrical/Electronic	2.5	
Painting	1.6	
Carpentry	2.3	
Welding	1.2	
Storage and Warehouse		
Inactive Storage	0.3	
Active Storage, Bulky	0.3	
Active Storage, Fine	1.0	
Material Handling	1.0	
Unlisted Space	0.2	
*Not less than 90 percent of all work stations shall be individually enclosed with partitions of at least the height described.		
PART B — SPECIFIC BUILDINGS		
Airport, Bus and Rail Station		
Baggage Area	1.0	
Concourse/Main Thruway	0.9	
Ticket Counter	2.5	
Waiting and Lounge Area	1.2	
Bank		
Customer Area	1.1	
Banking Activity Area	2.8	
Barber and Beauty Parlor	2.0	
Church, Synagogue, Chapel		
Worship/Congregational	2.5	
Preaching and Sermon	2.7	
Dormitory		
Bedroom	1.1	
Bedroom With Study	1.4	
Study Hall	1.8	
Fire and Police Department		
Fire Engine Room	0.7	
Detention Dayroom	1.5	
Jail Cell	1.2	

(continued)

TABLE 63.1049—continued
UNIT POWER DENSITIES

PART B — SPECIFIC BUILDINGS—continued		
Activity/Area	UPD W/ft²	Note
Hospital/Nursing Home		
Corridor	1.3	b
Dental Suite/Examination/Treatment	1.6	
Emergency	2.3	
Laboratory	3.0	
Lounge/Waiting Room	0.9	
Medical Supplies	2.4	
Nursery	2.0	
Nurse Station	2.1	
Occupational Therapy/Physical Therapy	1.6	
Patient Room	1.4	
Pharmacy	1.7	
Radiology	2.1	
Surgical and O.B. Suites		
General Area	2.1	
Operating Room	7.0	
Recovery	2.3	
Hotel/Conference Center		
Banquet Room/Multipurpose	2.4	a
Bathroom/Powder Room	1.2	
Guestroom	1.4	
Public Area	1.2	
Exhibition Hall	2.6	
Conference/Meeting	1.8	a
Lobby	1.9	
Reception Desk	2.4	
Laundry		
Washing	0.9	
Ironing and Sorting	1.3	
Museum and Gallery		
General Exhibition	1.9	
Inspection/Restoration	3.9	
Storage (Artifacts)		
Inactive	0.6	
Active	0.7	
Post Office		
Lobby	1.1	
Sorting and Mailing	2.1	
Service Station/Auto Repair	1.0	
Theater		
Performance Arts	1.5	
Motion Picture	1.0	
Lobby	1.5	
Retail Establishments		
Merchandising and Circulation Area — Applicable to all lighting, including accent and display lighting, installed in merchandising and circulation areas	2.2	g
Mall Concourse	1.4	
Retail Support Areas		
Tailoring	2.1	
Dressing/Fitting Rooms	1.4	

(continued)

TABLE 63.1049—continued
UNIT POWER DENSITIES

PART C — INDOOR ATHLETIC AREAS[e,f]		
Activity/Area	UPD W/ft²	Note
Seating Area, All Sports	0.4	
Badminton		
Club	0.5	
Tournament	0.8	
Basketball/Volleyball		
Intramural	0.8	
College	1.3	
Professional	1.9	
Bowling		
Approach Area	0.5	
Lanes	1.1	
Boxing or Wrestling (platform)		
Amateur	2.4	
Professional	4.8	
Gymnasium		
General Exercising and Recreation Only	1.0	
Handball/Raquetball/Squash		
Club	1.3	
Tournament	2.6	
Hockey, Ice		
Amateur	1.3	
College or Professional	2.6	
Skating Rink		
Recreational	0.9	
Exhibition/Professional	2.6	
Swimming		
Recreational	0.9	
Exhibition	1.5	
Under Water	1.0	
Tennis		
Recreational (Class III)	1.3	
Club/College (Class II)	1.9	
Professional (Class I)	2.6	
Tennis, Table		
Club	1.0	
Tournament	1.6	

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

Note: Not less than 90 percent of all work stations shall be individually enclosed with partitions of at least the height described.

a. A 1.5 power adjustment factor is applicable for multifunctional spaces.

b. Area factor of 1.0 shall be used for these spaces.

c. UPD includes lighting power required for clean-up purpose.

d. Area factor shall not exceed 1.55.

e. Area factor of 1.0 shall be used for all indoor athletic spaces.

f. Facilities that are used for more than one level of play shall have appropriate switching between the different levels specified in Table 63.1049. Dimming shall not be used to accomplish the reduction in illumination. The illumination at all levels shall be uniform.

g. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or 0.8 W/ft² times the floor area of the display area shall be added to the interior lighting power determined in accordance with this line item.

Comm 63.1050 Lighting controls that must be installed.

(1) Area controls.

(a) Except as provided in pars. (c) and (d), each interior area enclosed by ceiling-height partitions shall have an independent switching or control device. This switching or control device shall comply with all of the following:

1. Be readily accessible.
2. Located so that a person using the device can see the lights or area controlled by that switch, or so that the area being lit is annunciated.
3. Be manually operated, or automatically controlled by an occupant-sensing device that meets the requirements of s. Comm 63.1051 (4).

(b) Other devices may be installed in conjunction with the switching or control device required by par. (a) provided that they:

1. Permit the required switching or control device to override the action of the other devices; and
2. Reset the mode of any automatic system to normal operation without further action.

(c) Up to $^1/_2$ watt per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress are exempt from par. (a) if:

1. The area is designated a security or emergency egress area on the plans and specifications submitted to the department; and
2. The area is controlled by switches accessible only to authorized personnel.

(d) Public areas with switches that are accessible only to authorized personnel are exempt from the area control requirements of par. (a).

(2) Controls to reduce lighting.

(a) Except as provided in par. (b), the general lighting of any enclosed interior space 100 square feet (9.3 m^2) or larger in which the connected lighting load exceeds 1.2 watts per square foot for the space as a whole, and that has more than one light source or luminaire, shall be controlled so that the load for the lights may be reduced by at least one-half while maintaining a reasonably uniform level of illuminance throughout the area. A reasonably uniform reduction of illuminance shall be achieved by one of the following:

1. Controlling all lamps or luminaires with dimmers.
2. Dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps.
3. Switching the middle lamps of three lamp luminaires independently of the outer lamps.
4. Switching each luminaire or each lamp.
5. Other methods approved by the department.

(b) The requirements of par. (a) do not apply to any of the following:

1. Lights in areas that are controlled by an occupant-sensing device that meets the requirements of s. Comm 63.1051 (4).
2. Lights in corridors.
3. Lights in areas that are controlled by an automatic time switch control device that has a timed manual override available at each switch location required by sub. (1), and that controls only the lights in that area enclosed by ceiling height partitions.

(3) Daylit areas.

(a) Except as provided in par. (b), daylit areas in any interior enclosed space greater than 250 square feet (23 m^2) and a lighting density more than 1.2 W/ft^2 shall meet the requirements of subds. 1. and 2.

1. Such areas shall have at least one control that complies with all of the following:
   a. Controls only luminaires in the daylit area.
   b. Controls at least 50 percent of the lamps or luminaires in the daylit area, in a manner described in sub. (2)(a) 1. to 5., independently of all other lamps or luminaires in the enclosed space. The other luminaires in the enclosed space may be controlled in any manner allowed by sub. (2)(a) 1. to 5.
2. Such areas shall have controls that control the luminaires in each vertically daylit area separately from the luminaires in each horizontally daylit area.

(b) The requirements of this subsection do not apply to any of the following:

1. Daylit areas where the effective aperture of glazing is equal or less than 0.1 for vertical glazing and 0.01 for horizontal glazing.
2. Daylit areas where existing adjacent structures or natural objects obstruct daylight to the extent that effective use of daylighting is not feasible.

(4) Shutoff controls.

(a) Except as provided in par. (b), for every floor or metered space, all interior lighting systems shall be equipped with at least one separate automatic control to shut off the lighting. This automatic control shall meet the requirements of s. Comm 63.1051 and may be an occupancy sensor, automatic time switch, or other device capable of automatically shutting off the lighting.

(b) The requirements of par. (a) do not apply to any of the following:

1. Buildings or separately metered spaces of less than 5,000 square feet (464 m^2) of space.
2. Where the system is serving an area that must be continuously lit, or where the use of the

space prohibits the use of a preestablished lighting program.

Note: Service equipment rooms as specified in NEC 110-26 (3) (d) are covered by this exception.

3. In residential buildings, hotels and motels, lighting of corridors, guestrooms, and lodging quarters.
4. Up to $^1/_2$ watt per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, if:
   a. The area is designated a security or emergency egress area on the plans and specifications submitted to the department; or
   b. The area is controlled by switches accessible only to authorized personnel.

(c) If an automatic time switch control device is installed to comply with par. (a), it shall incorporate an override switching device that complies with all of the following:

1. Is readily accessible.
2. Is located so that a person using the device can see the lights or the area controlled by that switch, or so that the area being lit is annunciated.
3. Is manually operated.
4. Allows the lighting to remain on for no more than 2 hours when an override is initiated.
5. Controls an area not exceeding 20,000 square feet (1858 m^2) in malls, auditoriums, gymnasiums, single tenant retail spaces, factories, warehouses and arenas, and not exceeding 5,000 square feet (464 m^2) for other uses.
6. Two overrides may be provided for a maximum of 10,000 square feet (929 m^2) if the lighting is dual level controlled in accordance with sub. (2) (a) 2. or 3.

(5) Display lighting controls. Display lighting shall be separately switched on circuits that are 20 amps or less.

(6) Exterior lighting controls. Except in lighting in parking garages, tunnels, and large covered areas that require illumination during daylight hours, exterior lighting shall be controlled by a directional photocell or astronomical time switch that automatically turns off the exterior lighting when daylight is available. Time switches shall be equipped with backup provisions to keep time during a power outage of 10 hours or more.

(7) Hotel and motel guestroom controls. Hotel and motel guestrooms or suites excluding bathrooms shall have one or more master switches at the main entry door or at the entry door of each room that turn off all permanently wired lighting fixtures and switched receptacles in the room or suite.

Comm 63.1051 Requirements for lighting control devices. Automatic time switch control devices, occupant-sensing devices, automatic daylighting control devices, lumen maintenance control devices, or interior photocell sensor devices that are used to justify a wattage reduction factor in the calculation of the actual internal lighting power in s. Comm 63.1045 (2) shall be approved for compliance with all of the applicable requirements of subs. (1) to (7) and shall be installed in compliance with sub. (8). Approval of devices shall be obtained via the material approval program in accordance with ch. Comm 61 or via manufacturer certification to the California Energy Commission.

Note: Information on California Energy Commission Certification may be obtained from the California Energy Commission, Energy Efficiency and Demand Analysis Division, 1516 9th Street, MS-25, Sacramento, CA 95814, (916) 654-5106. A list of approved control devices is available at www.energy.ca.gov.

(1) All devices: instructions for installation and calibration. The manufacturer shall provide step-by-step instructions for installation and start-up calibration of the device.

(2) All devices: status signal. The device shall have an indicator that visibly or audibly informs the device operator that it is operating properly, or that it has failed or malfunctioned, except for photocell sensors or other devices where a status signal is infeasible because of inadequate power.

(3) Automatic time switch control devices. Automatic time switch control devices shall comply with all of the following:

(a) Be capable of programming different schedules for weekdays and weekends.

(b) Incorporate an automatic "holiday shutoff" feature that turns off all loads for at least 24 hours, then resumes the normally scheduled operation.

(c) Have program backup capabilities that prevent the loss of the device's program and time setting for at least 10 hours if power is interrupted.

(4) Occupant-sensing devices. Occupant-sensing devices shall be capable of automatically controlling all the lights in an area no more than 30 minutes after the area has been vacated. In addition, ultrasonic and microwave devices shall have a built-in mechanism that allows calibration of the sensitivity of the device to room movement in order to reduce the false sensing of occupants and shall comply with either par. (a) or (b), as applicable:

(a) If the device emits ultrasonic radiation as a signal for sensing occupants within an area, the device shall comply with all of the following:

1. Have had an Initial Report submitted to the Bureau of Radiological Health, Federal Food and Drug Administration, under 21 CFR 1002.10.
2. Emit no audible sound.
3. Not emit ultrasound in excess of the decibel (dB) values given in Table 63.1051 measured no more than 5 feet (1524 mm) from the source on axis.

TABLE 63.1051
MAXIMUM ULTRASOUND EMISSIONS

MIDFREQUENCY OF SOUND PRESSURE THIRD-OCTAVE BANK (in kHz)	MAXIMUM dB LEVEL WITHIN THIRD-OCTAVE BAND (in dB reference 20 micropascals)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

(b) If the device emits microwave radiation as a signal for sensing occupants within area, the device shall comply with all of the following:

1. Comply with all applicable provisions in 47 CFR Part 5, and have an approved Federal Communications Commission identification number that appears on all units of the device and that has been submitted to the department.
2. Not emit radiation in excess of 1 milliwatt per square centimeter measured at no more than 5 centimeters from the emission surface of the device.
3. Have permanently affixed to it installation instructions recommending that it be installed at least 12 inches (305 mm) from any area normally used by room occupants.

(5) Automatic daylighting control devices. Automatic daylighting control devices shall comply with all of the following:

(a) Be capable of reducing the light output of the general lighting of the controlled area by at least one-half while maintaining a uniform level of illluminance throughout the area.

(b) If the device is a dimmer, provide electrical outputs to lamps for reduced flicker operation through the dimming range and without causing premature lamp failure.

(c) If the device is a stepped dimming system, incorporate time delay circuits to prevent cycling of light level changes of less than 3 minutes.

(d) If the device uses step switching with separate "on" and "off" settings for the steps, have sufficient separation or deadband of "on" and "off" points to prevent cycling.

(e) Have provided by the manufacturer step-by-step instructions for installation and start-up calibration to design foot-candle levels.

(6) Lumen maintenance control devices. Lumen maintenance control devices shall comply with all of the following:

(a) Be capable of reducing the light output of the general lighting of the controlled area by at least 30 percent while maintaining a uniform illuminance throughout the area.

(b) Provide electrical outputs to lamps for reduced flicker operation through the dimming range and without causing premature lamp failure.

(c) Incorporate an alarm, either audible or visible, to announce when a specified setpoint of lumens or watts has been reached.

(d) Have provided by the manufacturer step-by-step instructions for installation and start up calibration to design foot-candle levels.

(7) Interior photocell sensor devices. Interior photocell sensors shall not have a mechanical slide cover or other device that permits easy unauthorized disabling of the control, and shall not be incorporated into a wall-mounted occupant-sensing device.

(8) Installation in accordance with manufacturer's instructions. If an automatic time switch control device, occupant-sensing device, automatic daylighting control device, lumen maintenance control device, or interior photocell sensor device is installed, it shall comply with both pars. (a) and (b).

(a) The device shall be installed in accordance with the manufacturer's instructions.

(b) Automatic daylighting control devices and lumen maintenance control devices shall:

1. Be installed so that automatic daylighting control devices control only luminaries within the daylit area; and
2. Have photocell sensors that are either ceiling mounted or located so that they are accessible only to authorized personnel, and that are located so that they maintain adequate illumination in the area according to the designer's or manufacturer's instructions.

Comm 63.1052 Exit signs. Exit signs shall have an installed wattage of 20 watts or less.

Comm 63.1053 Reduction of single-lamp ballasts. The following luminaries located within the same room shall be tandem wired or provided with three-lamp ballasts:

(1) One-lamp or three-lamp fluorescent luminaries recess-mounted within 10 feet (3048 mm) center-to-center of each other.

(2) One-lamp or three-lamp fluorescent luminaries pendant- or surface-mounted within 1 foot (305 mm) edge-to-edge of each other.

PART 6
NONDEPLETABLE ENERGY SOURCE

Comm 63.1060 Buildings utilizing solar, geothermal, wind or other nondepletable energy source. Any building, or portion thereof, utilizing any nondepletable energy source shall meet all the requirements in IECC Section 806.

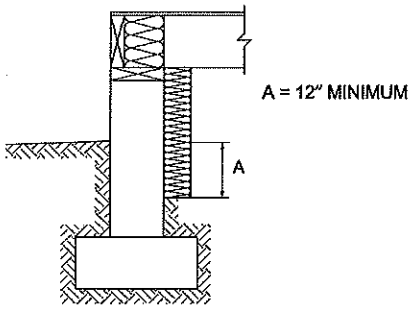
PART 7
SYSTEM ANALYSIS DESIGN

Comm 63.1070 System analysis design. A building designed using system analysis design shall comply with IECC Section 806.

APPENDIX

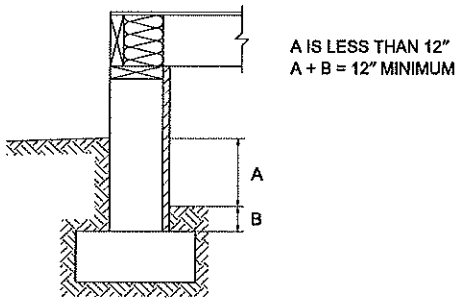
The sections and construction details in Details 502.2.1.5(1), 502.2.1.5(2) and 502.2.1.5(3), and Tables 502.2.3.1(1), 502.2.3.1(2), 502.2.3.1(3), 502.2.3.2, 502.2.3.3, 502.2.3.5 and 502.2.3.6 are intended to be representative and not all-inclusive. Adopting agencies are encouraged to add construction details and sections appropriate to their specific areas.

Utilization of these tables should be correlated with local industry group practices and model code research recommendations.



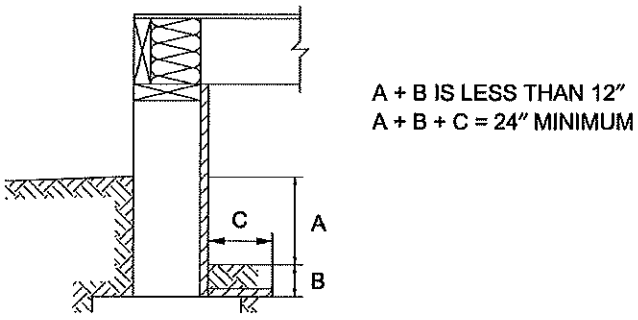
For SI: 1 inch = 25.4 mm.

DETAIL 502.2.1.5(1)
CRAWL SPACE WALL INSULATION—INSTALLATION #1



For SI: 1 inch = 25.4 mm.

DETAIL 502.2.1.5(2)
CRAWL SPACE WALL INSULATION—INSTALLATION #2

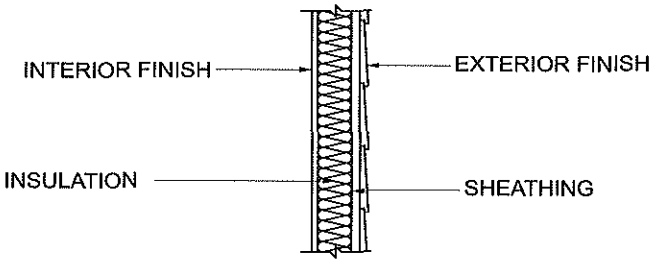
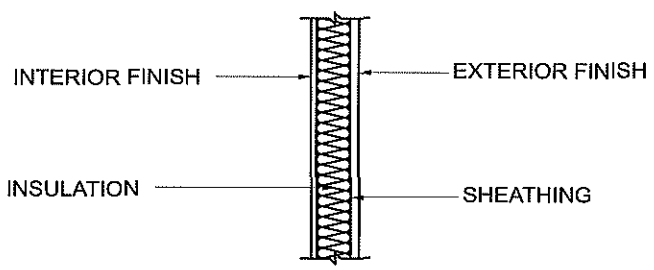


For SI: 1 inch = 25.4 mm.

DETAIL 502.2.1.5(3)
CRAWL SPACE WALL INSULATION—INSTALLATION #3[a]

a. Horizontal insulation placed on the inside ground surface shall be permitted where A + C = 24" minimum.

TABLE 502.2.3.1(1)
WALL ASSEMBLIES
(U_w selected shall not exceed the U_o determined by Section 502.2.3.1 for any wall section)

WALL DETAILS[2]		TYPE AND SPACING OF FRAMING (nominal)	*R*-VALUE OF CAVITY INSULATION	*R*-VALUE OF SHEATHING	U_w[b]
Typical schedules:					
Typical interior finish— 1. Gypsum wallboard 2. Lath and plaster 3. 0.375″ minimum wood paneling	Typical exterior finish— 1. Stucco 2. Wood or plywood siding 3. Brick veneer				
WOOD STUD CONSTRUCTION  		4″ Studs @ 16″ o.c.	11	non-insul	0.085
			13	non-insul	0.076
			13	3	0.064
			13	5	0.056
			13	7	0.051
			15	non-insul	0.070
			15	3	0.059
			15	5	0.053
			15	7	0.048
		6″ Studs @ 16″ o.c.	19	non-insul	0.058
			19	3	0.050
			19	5	0.046
			19	7	0.041
			21	non-insul	0.052
			21	3	0.046
			21	5	0.042
			21	7	0.038
		6″ Studs @ 24″ o.c.	21	non-insul	0.050
STEEL STUD CONSTRUCTION  		4″ Studs @ 16″ o.c.	11	non-insul	0.14
			13	non-insul	0.13
		6″ Studs @ 16″ o.c.	19	non-insul	0.11
		4″ Studs @ 24″ o.c.	11	non-insul	0.12
			13	non-insul	0.11
		6″ Studs @ 24″ o.c.	19	non-insul	0.10

For SI: 1 inch = 25.4 mm.

a. Details shown are for insulation and are not complete construction details.

b. U_w calculated based on the ASHRAE *Handbook of Fundamentals*.

TABLE 502.2.3.1(2)
WALL ASSEMBLIES
(U_W selected shall not exceed the U_o determined by Section 502.2.3.1 for any wall section)

WALL DETAILS[f]	R-VALUE OR TYPE	U_W AND R_o FOR WALL THICKNESS LISTED[a]				
			6″	8″	10″	12″
Plain concrete masonry Block construction	No insulation No interior finish	U_W R_o	0.37 2.70	0.33 3.03	0.31 3.23	0.30 3.33
	Loose fill in cores No interior finish	U_W R_o	0.18 5.56	0.13 7.69	0.11 9.09	0.09 11.11
	No insulation Interior finish	U_W R_o	0.24 4.17	0.23 4.35	0.22 4.55	0.21 4.76
	No insulation Foil-backed gypsum board interior finish	U_W R_o	0.18 5.56	0.17 5.88	0.16 6.25	0.16 6.25
	1″ extruded polystyrene Interior finish	U_W R_o	0.13 7.69	0.13 7.69	0.12 8.33	0.12 8.33
	2″ expanded polystyrene Interior finish	U_W R_o	0.09 11.11	0.09 11.11	0.09 11.11	0.09 11.11
	2″ extruded polystyrene Interior finish	U_W R_o	0.08 12.50	0.08 12.50	0.08 12.50	0.08 12.50
	2″ polyisocyanurate Interior finish	U_W R_o	0.06 16.67	0.06 16.67	0.06 16.67	0.06 16.67
	R-11, 2 × 3 studs Interior finish	U_W R_o	0.07 14.29	0.07 14.29	0.07 14.29	0.07 14.29
	R-13, 2 × 3 studs Interior finish	U_W R_o	0.06 16.67	0.06 16.67	0.06 16.67	0.06 16.67
	R-19, 2 × 4 studs Interior finish	U_W R_o	0.05 20.00	0.05 20.00	0.05 20.00	0.05 20.00
	MULTI-WYTHE WALLS	U_W AND R_o FOR WALL THICKNESS LISTED[b,c,d,e]				
			8″	10″	12″	14″
Cavity insulation and interior finish: 0.5-inch gypsum board on furring strips	No insulation No interior finish	U_W R_o	0.32 3.13	0.26 3.85	0.24 4.17	0.22 4.55
	Loose fill in cavity No interior finish	U_W R_o	NA NA	0.12 8.33	0.12 8.33	0.11 9.09
	Loose fill Interior finish	U_W R_o	0.11 9.03	0.10 10.00	0.10 10.00	0.10 10.00
	Loose fill foil-backed gypsum board Interior finish	U_W R_o	0.10 10.00	0.09 11.11	0.09 11.11	0.09 11.11
	1″ expanded polystyrene in cavity Interior finish	U_W R_o	NA NA	0.13 7.69	0.12 8.33	0.12 8.33
	2″ expanded polystyrene in cavity Interior finish	U_W R_o	NA NA	0.08 12.50	0.08 12.50	0.08 12.50
	1″ extruded polystyrene in cavity Interior finish	U_W R_o	NA NA	0.11 9.09	0.11 9.09	0.11 9.09
	2″ extruded polystyrene in cavity Interior finish	U_W R_o	NA NA	0.07 14.29	0.07 14.29	0.07 14.29
	1″ polyisocyanurate in cavity Interior finish	U_W R_o	NA NA	0.08 12.50	0.08 12.50	0.08 12.50
	2″ polyisocyanurate in cavity Interior finish	U_W R_o	NA NA	0.05 20.00	0.05 20.00	0.05 20.00
	1″expanded polystyrene in cavity foil-backed gypsum board Interior finish	U_W R_o	NA NA	0.09 11.11	0.09 11.11	0.09 11.11
	1″ extruded polystyrene in cavity foil-backed gypsum board Interior finish	U_W R_o	NA NA	0.08 12.50	0.08 12.50	0.08 12.50

For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 0.1572 kg/m^3.

a. The U_W values are for blocks made with concrete having a density of 80 pounds per cubic foot; for other densities, the U_W must be calculated based on the R-values provided in NCMA 6-1A or the ASHRAE *Handbook of Fundamentals*.

b. 8″ composite wall: 4″ dense outer wythe and hollow-unit inner wythe.

c. 10″ cavity wall: 4″ dense outer wythe, 2″ air space and 4″ hollow-unit inner wythe.

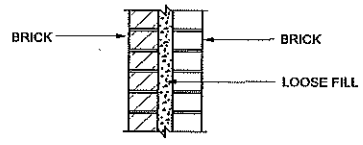
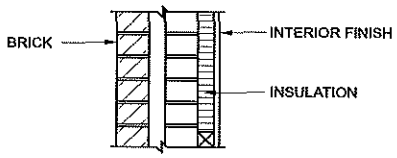
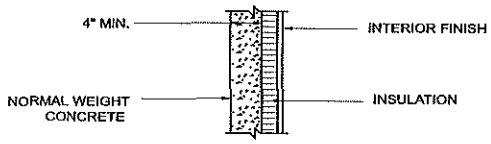
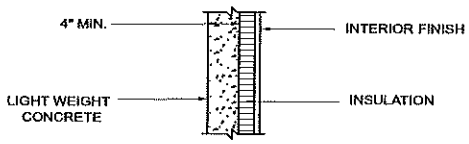
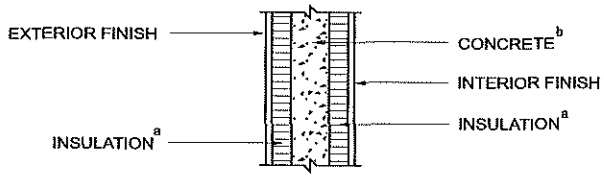
d. 12″ cavity wall: 4″ dense outer wythe, 2″ air space and 6″ hollow-unit inner wythe.

e. 14″ cavity wall: 4″ dense outer wythe, 2″ air space and 8″ hollow-unit inner wythe.

f. Refer to drawings in Tables 502.2.3.1(1) and 502.2.3.1(3).

NA = Not Applicable.

TABLE 502.2.3.1(3)
WALL ASSEMBLIES
(U_w selected shall not exceed the U_o determined by Section 502.2.3.1 for any wall section)

WALL DETAILS[d] Interior finish 0.25″ gypsum board applied on furring strips	*R*-VALUE OF INSULATION	U_w	R_o
BRICK MASONRY CONSTRUCTION WITH LOOSE FILL 	Solid grout in space	0.38	2.63
	2″ space with loose fill R-4	0.16	6.25
	4″ space with loose fill R-8	0.10	10.00
BRICK MASONRY CONSTRUCTION WITH INSULATION 	4	0.12	8.33
	6	0.09	11.11
	11	0.07	14.29
NORMAL-WEIGHT CONCRETE CONSTRUCTION 	4	0.18	5.56
	6	0.13	7.69
	7	0.12	8.33
	11	0.08	12.50
LIGHTWEIGHT CONCRETE CONSTRUCTION 	4	0.17	5.88
	6	0.12	8.33
	7	0.11	9.09
	11	0.08	12.50
INSULATING CONCRETE FORM SYSTEM (ICF)[c] 	12	0.07	13.55
	15	0.06	16.55
	16	0.06	17.55
	17	0.05	18.55
	20	0.05	21.55
	22	0.04	23.55

For SI: 1 inch = 25.4 mm.

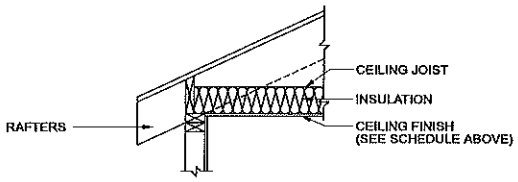
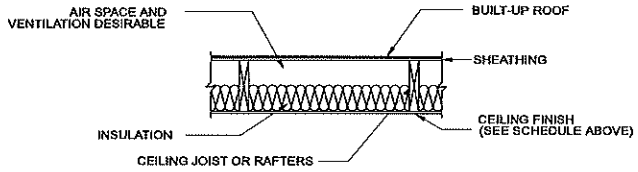
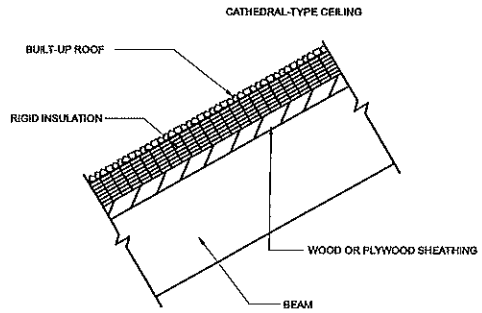
a. The *R*-value listed is the sum of the values for the exterior and interior insulation layers.

b. The manufacturer shall be consulted for the U_w and R_o values if the insulated concrete form system (ICF) uses metal form ties to connect the interior and exterior insulation layers.

c. These values shall be permitted to be used for concrete masonry wall assemblies with exterior and interior insulation layers.

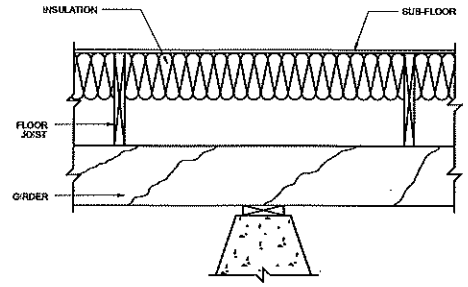
d. Details shown are for insulation and are not complete construction details.

TABLE 502.2.3.2
ROOF/CEILING ASSEMBLIES
(U_r selected shall not exceed the value specified in Section 502.2.3.2)

ROOF DETAILS[a, b] Typical interior finish schedule: 1. Gypsum wallboard 2. Lath & plaster	*R*-VALUE OF INSULATION[b]	U_r	R_o
	19	0.05	20.00
	22	0.04	25.00
	30	0.03	33.33
	38	0.025	40.00
	19	0.05	20.00
	22	0.04	25.00
	30	0.03	33.33
	38	0.025	40.00
	**Wood decking**		
	9	0.08	12.50
	Plywood		
	10	0.08	12.50
	19	0.05	20.00
	30	0.03	33.33

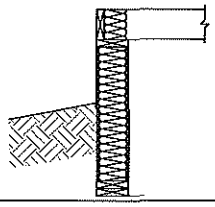
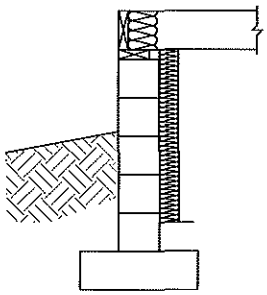
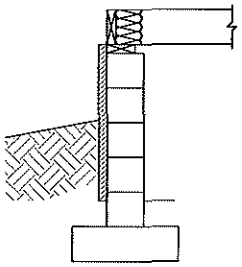
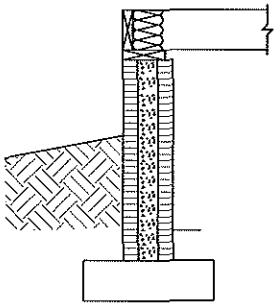
a. Details shown are for insulation and are not complete construction details.
b. Skylights not exceeding one percent of the roof are permitted.
c. Insulation installed between joints.

TABLE 502.2.3.3
FLOOR ASSEMBLIES
(U_r selected shall not exceed the U_o specified in Section 502.2.3.3)

FLOOR DETAILS[a]	*R*-VALUE OF INSULATION	U_r	R_o
	No insulation	0.32	3.13
	7	0.11	9.09
	11	0.08	12.50
	19	0.05	20.00

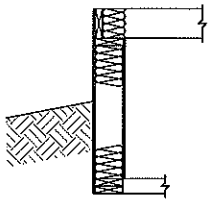
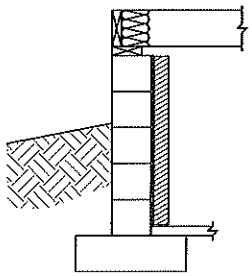
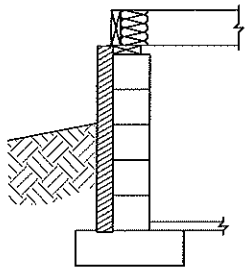
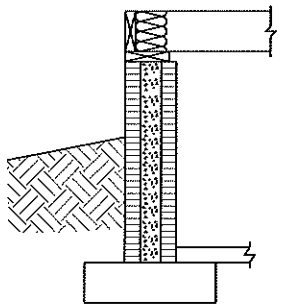
a. Details shown are for insulation and are not complete construction details.

TABLE 502.2.3.5
CRAWL SPACE FOUNDATION WALL ASSEMBLIES
(*U*-factor selected shall not exceed the *U*-factor determined by Section 502.2.3.5)

WALL DETAILS[a]	*R*-VALUE OF INSULATION	*U*-FACTOR
WOOD FOUNDATION 	11	0.10
	13	0.09
	19	0.06
CONCRETE/MASONRY FOUNDATION—INTERIOR INSULATION 	5	0.15
	10	0.08
	11	0.08
	13	0.07
	19	0.05
CONCRETE/MASONRY FOUNDATION—EXTERIOR INSULATION 	3	0.20
	5	0.15
	10	0.08
	15	0.06
INSULATING CONCRETE FORM SYSTEM (ICF)[b, c, d] 	12	0.08
	15	0.06
	16	0.06
	17	0.06
	20	0.05
	22	0.04

a. Details shown are for insulation and are not complete construction details.
b. The *R*-value listed is the sum of the values for the exterior and interior insulation layers.
c. The manufacturer shall be consulted for the *U*-factor if the insulated concrete form system (ICF) uses metal form ties to connect the interior and exterior insulation layers.
d. These values shall be permitted to be used for concrete masonry wall assemblies with exterior and interior insulation layers.

TABLE 502.2.3.6
BASEMENT FOUNDATION WALL ASSEMBLIES
(*U*-factor selected shall not exceed the *U*-factor determined by Section 502.2.3.6)

WALL DETAILS[a]	*R*-VALUE OF INSULATION	*U*-FACTOR
WOOD FOUNDATION 	11	0.08
	13	0.08
	19	0.06
CONCRETE/MASONRY FOUNDATION—INTERIOR INSULATION 	5	0.15
	6.5	0.12
	10	0.08
	11	0.08
	19	0.06
CONCRETE/MASONRY FOUNDATION—EXTERIOR INSULATION 	3	0.20
	5	0.15
	10	0.09
	15	0.06
INSULATING CONCRETE FORM SYSTEM (ICF)[b, c, d] 	12	0.07
	15	0.06
	16	0.06
	17	0.05
	20	0.05
	22	0.04

a. Details shown are for insulation and are not complete construction details.
b. The *R*-value listed is the sum of the values for the exterior and interior insulation layers.
c. The manufacturer shall be consulted for the *U*-value if the insulated concrete form system (ICF) uses metal form ties to connect the interior and exterior insulation layers.
d. These values shall be permitted to be used for concrete masonry wall assemblies with exterior and interior insulation layers.

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