ADDENDA

2013 Supplement

ANSI/ASHRAE/IES Addenda e, f, i, l, m, n, q, r, u, w, aa, ad, ae, af, ag, ah, ai, aj, al, am, an, ap, aq, ar, as, at, au, av, aw, ax, ay, az, ba, bb, bc, bd, be, bf, bg, bh, bi, bj, bk, bl, bn, bo, bp, bq, br, bs, bt, bv, bw, bx, by, ca, cb, cc, cd, ce, cf, ch, cj, ck, cl, cm, cn, co, cp, cr, ct, cv, cy, cz, da, db, dc, dd, de, dg, di, dj, dk, dl, dm, dn, do, dp, dq, dr, dt, dv, and dw
to ANSI/ASHRAE/IES Standard 90.1-2010

Energy Standard for Buildings Except Low-Rise Residential Buildings

See Appendix for approval dates.

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 ISSN 1041-2336

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Addenda f, w, af, aj, al, am, aq, ar, av, ax, ay, bc, bd, bg, bh, bi, bj, br, bt, bv, ca, cc, ce, ch, cj, ck, cm, cn, and cp
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ASHRAE Standing Standard Project Committee 90.1 for
Addenda e, l, m, n, q, ad, ah, ai, as, and at
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Addenda r, aa, ae, ag, ak, an, ba, bf, bl, bn, bo, bp, bs, bw, by, cb, cd, cf, cl, co, cr, ct, cv, cy, cz, da, db, dc, dd, de, dg, di, dj, dk, dl, dn, do, dp, dq, dr, dt, dv, and dw
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ANSI/ASHRAE 2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings

NOTE

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FOREWORD

This addendum modifies Appendix G of Standard 90.1 to create a consistent baseline building envelope for the Performance Rating Method. Standard 90.1-2010 specifies that the baseline building envelope of an existing building reflect the existing conditions rather than the minimum prescriptive requirements of the standard as specified for new buildings and additions.

This addendum will provide more consistency in the Performance Rating Method, as all other regulated building components (e.g., mechanical and lighting systems) currently require that the baseline building model be consistent with the standard's prescriptive requirements, regardless of whether the project is new construction or modification to an existing building.

Section G1.1 states that the Performance Rating Method "is intended for use in rating the energy efficiency of building designs that exceed the requirements of" Standard 90.1 and is "provided for those wishing to use the methodology developed for this standard to quantify performance that substantially exceeds the requirements of Standard 90.1." This addendum modifies the standard to meet the intent and scope of Appendix G.

***Note:** In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum e to Standard 90.1-2010

Modify Table G3.1 as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No. Proposed Building Performance	Baseline Building Performance
5. Building Envelope	
[There are no changes to this section]	Equivalent dimensions shall be assumed for each exterior envelope component type as in the *proposed design*; i.e., the total gross area of exterior *walls* shall be the same in the *proposed* and *baseline building designs*. The same shall be true for the areas of *roofs*, floors, and *doors*, and the exposed perimeters of concrete slabs on *grade* shall also be the same in the *proposed* and *baseline building designs*. The following additional requirements shall apply to the modeling of the *baseline building design*: a. **Orientation.** The *baseline building performance* shall be generated by simulating the building with its actual *orientation* and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. **Exceptions:** 1. If it can be demonstrated to the satisfaction of the *Program Evaluator* that the building *orientation* is dictated by site considerations. 2. Buildings where the *vertical fenestration area* on each *orientation* varies by less than 5%. b. **Opaque Assemblies.** *Opaque* assemblies used for new buildings, existing buildings, or *additions* shall conform with the following common, lightweight assembly types and shall match the appropriate assembly maximum *U-factors* in Tables 5.5-1 through 5.5-8: • *Roofs*—Insulation entirely above deck • *Above-grade walls*—Steel-framed • Floors—Steel-joist • *Opaque door* types shall match the *proposed design* and conform to the *U-factor* requirements from the same tables. • *Slab-on-grade floors* shall match the *F-factor* for unheated slabs from the same tables. ~~*Opaque* assemblies used for *alterations* shall conform with Section 5.1.3.~~ c. **Vertical Fenestration Areas.** *Vertical fenestration areas* for new buildings and *additions* shall equal that in the *proposed design* or 40% of gross *above-grade wall* area, whichever is smaller, and shall be distributed on each face of the building in the same proportions in the *proposed design*. The *fenestration* area for an *existing building* shall equal the existing *fenestration* area prior to the proposed work and shall be distributed on each face of the building in the same proportions as the *existing building*. ~~*Fenestration U-factors* shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. *Fenestration* SHGC shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. All vertical glazing shall be assumed to be flush with the exterior *wall*, and no shading projections shall be modeled. *Manual* window shading devices such as blinds or shades are not required to be modeled. The *fenestration areas* for envelope *alterations* shall reflect the limitations on area, *U-factor*, and SHGC as described in Section 5.1.3.~~ d. **Vertical Fenestration Assemblies.** *Fenestration* for new buildings, existing buildings, and additions shall comply with the following: • *Fenestration* U-factors shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. • *Fenestration* SHGCs shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. • All *vertical fenestration* shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled. • Manual window shading devices such as blinds or shades are not required to be modeled. ~~d~~e. **Roof Solar *Reflectance* and Thermal *Emittance*.** The exterior *roof* surfaces shall be modeled with a solar *reflectance* and thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled using a solar *reflectance* of 0.30 and a thermal *emittance* of 0.90. ~~e~~f. **Roof Albedo.** All roof surfaces shall be modeled with a reflectivity of 0.30. ~~f. **Existing Buildings.** For *existing building envelopes*, the *baseline building design* shall reflect existing conditions prior to any revisions that are part of the scope of work being evaluated.~~

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FOREWORD

This addendum establishes baseline window-to-wall areas for different building types. Prior to this addendum, the baseline building window area was equal to the proposed building window area, provided that the proposed area was below the prescriptive limit (40%). This has several negative consequences. It caused the baseline energy performance to vary in response to the design window area, so that the baseline becomes a moving target. As a result, two similar buildings with very different energy uses due to differences in window area could have the same performance rating. Another outcome of the existing approach is that projects that use an integrated design process, optimizing window area to balance heating and cooling loads with daylighting energy savings, are not rewarded. The baseline includes the same optimized window area, which has been a frustration to many design teams. This addendum sets the window area to a level that is average for each building type so that the proposed design will reflect the energy implications of window area.

The window areas in Table G3.3 were developed from the Commercial Building Energy Consumption Survey (CBECS) and reflect the average window area of new construction for each building type between 1980 and 2003.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum f to Standard 90.1-2010

Modify Table G3.1 as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
5.	**Building Envelope Baseline Building Performance**	
		c. **Vertical Fenestration.** For building area types included in Table G3.3, vertical fenestration areas for new buildings and additions shall equal that in Table G3.3, based on gross above grade exterior wall area. Where a building has multiple building area types, each type shall use the values in the table. The vertical fenestration shall be distributed on each face of the building in the same proportion as in the proposed design. For building areas not shown in Table G3.3, ~~V~~vertical fenestration areas for new buildings and additions shall equal that in the proposed design or 40% of gross above-grade wall area, whichever is smaller, and shall be distributed on each face of the building in the same proportions in the proposed design. Fenestration U-factors shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. Fenestration SHGC shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. All vertical glazing shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled. Manual window shading devices such as blinds or shades are not required to be modeled. The fenestration areas for envelope alterations shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3.

Modify the following Table G3.3 (I-P units).

TABLE G3.3 Baseline Building Vertical Fenestration Percentage of Gross Above-Grade-Wall Area

Building Area Types[a]	Baseline Building Gross above Grade Wall Area
Grocery Store	7%
Healthcare (outpatient)	21%
Hospital	27%
Hotel/motel (≤75 rooms)	24%
Hotel/motel (>75 rooms)	34%
Office (≤5000 ft^2)	19%
Office (5000–50,000 ft^2)	31%
Office (>50,000 ft^2)	40%
Restaurant (quick service)	34%
Restaurant (full service)	24%
Retail (stand alone)	11%
School (primary)	22%
School (secondary and university)	22%
Warehouse (nonrefrigerated)	6%

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

Add the following table G3.3 (SI units).

TABLE G3.3 Baseline Building Vertical Fenestration Percentage of Gross Above-Grade-Wall Area

Building Area Types[a]	Baseline Building Gross above Grade Wall Area
Grocery Store	7%
Healthcare (outpatient)	21%
Hospital	27%
Hotel/motel (≤75 rooms)	24%
Hotel/motel (>75 rooms)	34%
Office (≤465 m^2)	19%
Office (465–4650 m^2)	31%
Office (>4650 m^2)	40%
Restaurant (quick service)	34%
Restaurant (full service)	24%
Retail (stand alone)	11%
School (primary)	22%
School (secondary and university)	22%
Warehouse (nonrefrigerated)	6%

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

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FOREWORD

The minimum energy efficiency standards for single package vertical air conditioners (SPVAC) and heat pumps (SPVHP) were last amended in the 2007 version of ASHRAE 90.1. This addendum updates the minimum EERs and COPs listed in Table 6.8.1D and establishes a new product class for space constrained products. This new product class is specifically intended to address SPVACs and SPVHPs used in space constrained applications. In addition, this new product class only applies to non-weatherized products with cooling capacities less than 36,000 Btu/h and intended to replace an existing air conditioner, heat pump or gas/electric unit installed in an existing exterior wall opening. The effective date of the amended standards is January 1, 2012.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum i to Standard 90.1-2010

Add new definition in Section 3.2 for nonweatherized single-package vertical units (I-P and SI inits).

nonweatherized space constrained single-package vertical unit: a single-package vertical air conditioner (SPVAC) or single-Package vertical heat pump (SPVHP) that meets all of the following:

a. is for indoor use only
b. has rated cooling capacities no greater than 36,000 Btu/h (11 kW)
c. is a single-package unit requiring an opening in an exterior wall with overall exterior dimensions that requires or uses an existing sleeve that meets one of the following criteria:
    1. width of less than 32 in. (813 mm) and height of less than 45 in. (1143 mm)
    2. fits inside an existing 1310 in.^{2} (845,160 mm^2) opening
d. is commonly installed in site-built commercial buildings
e. is of a similar cooling capacity and, if a heat pump, similar heating capacity;
f. draws outdoor air for heat exchange directly through an existing opening, used for both inlet and outlet, in the exterior wall;
g. is restricted to applications where an existing air conditioner, heat pump, or gas/electric unit, installed in an existing exterior wall opening, is to be replaced;
h. bears a permanent "Replacement" marking, conspicuously placed, and clearly indicating, that its application is limited to installations where an existing air conditioner or heat pump is to be replaced.

Amend Table 6.8.1D to modify minimum energy efficiency requirements for single-package vertical units (air conditioners and heat pumps) and to add a new product class for nonweatherized space-constrained and single-package vertical heat pumps.

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	MinimumEfficiency	Test Procedure[a]
PTAC (cooling mode) standard size	All capacities	95°F db outdoor air	12.5 – (0.213 × Cap/1000)[c] EER (before 10/08/2012) 13.8 – (0.300 × Cap/1000)[c] EER (as of 10/08/2012)	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	95°F db outdoor air	10.9 – (0.213 × Cap/1000)c EER	
PTHP (cooling mode) standard size	All capacities	95°F db outdoor air	12.3 – (0.213 × Cap/1000)c EER (before 10/08/2012) 14.0 – (0.300 × Cap/1000)[c] EER (as of 10/08/2012)	
PTHP (cooling mode) nonstandard size[b]	All capacities	95°F db outdoor air	10.8 – (0.213 × Cap/1000)c EER	
PTHP (heating mode) standard size	All capacities	—	3.2 – (0.026 × Cap/1000)c COPH (before 10/08/2012) 3.7 – (0.052 × Cap/1000)[c] COPH (as of 10/08/2012)	
PTHP (heating mode) nonstandard size[b]	All capacities	—	2.9 – (0.026 × Cap/1000)[c] COPH	
SPVAC (cooling mode)	<65,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER (before 1/1/2012) 10.0 EER (as of 1/1/2012)	AHRI 390
	65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb outdoor air	8.9 EER (before 1/1/2012) 10.0 EER (as of 1/1/2012)	
	135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb outdoor air	8.6 EER(before 1/1/2012) 10.0 EER (as of 1/1/2012)	
SPVHP (cooling mode)	<65,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER (before 1/1/2012) 10.0 EER (as of 1/1/2012)	
	65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb outdoor air	8.9 EER (before 1/1/2012) 10.0 EER (as of 1/1/2012)	
	135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb outdoor air	8.6 EER (before 1/1/2012) 10.0 EER (as of 1/1/2012)	
SPVHP (heating mode)	<65,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP	
	65,000 Btu/h and <135,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP	
	135,000 Btu/h and <240,000 Btu/h	47°F db/43°F wb outdoor air	2.9 COP (before 1/1/2012) 3.0 COP (as of 1/1/2012)	

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements *(continued)*

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	MinimumEfficiency	Test Procedure[a]
SPVAC (cooling mode), non-weatherized space constrained	30,000 Btu/h	95°F db/75°F wb outdoor air	9.2 EER (as of 1/1/2012)	AHRI 390
	>30,000 Btu/h and 36,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER (as of 1/1/2012)	
SPVHP (cooling mode), non-weatherized space constrained	30,000 Btu/h	95°F db/75°F wb outdoor air	9.2 EER (as of 1/1/2012)	
	>30,000 Btu/h and 36,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER (as of 1/1/2012)	
SPVHP (heating mode), non-weatherized space constrained	30,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP (as of 1/1/2012)	
	>30,000 Btu/h and 36,000 Btu/h	47°F db/43°F wb outdoor air	3.0 COP (as of 1/1/2012)	
Room air conditioners, with louvered sides	<6000 Btu/h	—	9.7 SEER	ANSI/AHAM RAC-1
	6000 Btu/h and <8000 Btu/h		9.7 SEER	
	8000Btu/h and <14,000		9.8 SEER	
	14,000 Btu/h and <20,000 Btu/h		9.7 SEER	
	20,000 Btu/h		8.5 SEER	
Room air conditioners, without louvered sides	<8000 Btu/h	—	9.0 EER	
	Btu/h and <20,000 Btu/h		8.5 EER	
	20,000 Btu/h		8.5 EER	
Room air-conditioner heat pumps with louvered sides	<20,000 Btu/h	—	9.0 EER	
	20,000 Btu/h		8.5 EER	
Room air-conditioner heat pumps without louvered sides	<14,000 Btu/h	—	8.5 EER	
	14,000 Btu/h		8.0 EER	
Room air conditioner, casement only	All capacities	—	8.7 EER	
Room air conditioner, casement–slider	All capacities	—	9.5 EER	

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	MinimumEfficiency	Test Procedure[a]
PTAC (cooling mode) standard size	All capacities	35°C db outdoor air	3.66 – (0.213 × Cap/1000)[c] COP (before 10/08/2012) 4.04 – (0.300 × Cap/1000)[c] EER (as of 10/08/2012)	AHRI 310/380
PTAC (cooling mode) nonstandard size[b]	All capacities	35°C db outdoor air	3.19 – (0.213 × Cap/1000)[c] COP	
PTHP (cooling mode) standard size	All capacities	35°C db outdoor air	3.60 – (0.213 × Cap/1000)[c] COP (before 10/08/2012) 4.10 – (0.300 × Cap/1000)[c] EER (as of 10/08/2012)	
PTHP (cooling mode) nonstandard size[b]	All capacities	35°C db outdoor air	3.16 – (0.213 × Cap/1000)[c] COP	
PTHP (heating mode) standard size	All capacities	—	3.2 – (0.026 × Cap/1000)[c] COPH (before 10/08/2012) 3.7 – (0.052 × Cap/1000)[c] COPH (as of 10/08/2012)	
PTHP (heating mode) nonstandard size[b]	All capacities	—	2.9 – (0.026 × Cap/1000)[c] COPH	
SPVAC (cooling mode)	<19 kW	35°C db/23.9°C wb outdoor air	2.64 COP (before 1/1/2012 2.93 COP (as of 1/1/2012)	AHRI 390
	19 kW and <40 kW	35°C db/23.9°C wb outdoor air	2.61 COP (before 1/1/2012) 2.93 COP (as of 1/1/2012)	
	40kW and <70 kW	35°C db/23.9°C wb outdoor air	2.52 COP (before 1/1/2012) 2.93 COP (as of 1/1/2012)	
SPVHP (cooling mode)	<19 kW	35°C db/23.9°C wb outdoor air	2.64 COP (before 1/1/2012) 2.93 COP (as of 1/1/2012)	
	19 kW and <40 kW	35°C db/23.9°C wb outdoor air	2.61 COP (before 1/1/2012) 2.93 COP (as of 1/1/2012)	
	40kW and <70 kW	35°C db/23.9°C wb outdoor air	2.52 COP (before 1/1/2012) 2.93 COP (as of 1/1/2012)	
SPVHP (heating mode)	<19 kW	8.3°C db/6.1°C wb outdoor air	3.0 COP	
	19 kW and <40 kW	8.3°C db/6.1°C wb outdoor air	3.0 COP	
	40kW and <70 kW	8.3°C db/6.1°C wb outdoor air	2.9 COP (before 1/1/2012) 3.0 COP (as of 1/1/2012)	

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	MinimumEfficiency	Test Procedure[a]
SPVAC (cooling mode), non-weatherized space constrained	_9 kW	35°C db/23.9°C wb outdoor air	2.69 COP (as of 1/1/2012)	AHRI 390
	>9 kW and _11 kW	35°C db/23.9°C wb outdoor air	2.64 COP (as of 1/1/2012)	
SPVHP (cooling mode), non-weatherized space constrained	_9 kW	35°C db/23.9°C wb outdoor air	2.69 COP (as of 1/1/2012)	
	>9 kW and _11 kW	35°C db/23.9°C wb outdoor air	2.64 COP (as of 1/1/2012)	
SPVHP (heating mode), non-weatherized space constrained	_9 kW	8.3°C db/6.1°C wb outdoor air	3.0 COP (as of 1/1/2012)	
	>9 kW _11 kW	8.3°C db/6.1°C wb outdoor air	3.0 COP (as of 1/1/2012)	
Room air conditioners, with louvered sides	<1.8 kW	—	2.84 COP	ANSI/AHAM RAC-1
	1.8 kW and <2.3 kW		2.84 COP	
	2.3 kW and <4.1 kW		2.87 COP	
	4.1 kW and <5.9 kW		2.84 COP	
	5.9 kW		2.49 COP	
Room air conditioners, without louvered sides	<2.3 kW	—	2.64 COP	
	2.3 kW and <5.9 kW		2.49 COP	
	5.9 kW		2.49 COP	
Room air-conditioner heat pumps with louvered sides	<5.9 kW	—	2.65 COP	
	5.9 kW		2.49 COP	
Room air-conditioner heat pumps without louvered sides	<4.1 kW	—	2.49 COP	
	4.1 kW		2.34 COP	
Room air conditioner, casement only	All capacities	—	2.55 COP	
Room air conditioner, casement–slider	All capacities	—	2.78 COP	

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FOREWORD

Prior to the 2007 edition of Standard 90.1, only a simplified fan power limitation based on maximum allowed nameplate motor horsepower per cfm of supply air volume was available. While easy to use, this methodology did not accommodate some system designs, particularly those with devices that required increased pressure drops in the air delivery systems (such as energy recovery, pressure control valves, enhanced filters, etc.). To accommodate those designs, a more complex option based on maximum allowed brake horsepower was added. In order to ensure that the selected motor was not oversized more than a reasonable amount above the brake horsepower requirement, Section 6.5.3.1.2 was added, limiting the ratio of nameplate to brake horsepower. This new section was meant to apply only to the systems using the brake horsepower methodology, since systems using the nameplate horsepower methodology already had a nameplate limit. However, this section was inadvertently structured so that both systems complying with either the brake horsepower or nameplate horsepower options were required to perform these calculations, defeating the purpose of the simplified nameplate horsepower option. This addendum fixes that mistake.

Note: *In this addendum, changes to the current standard are indicated in the text by* <u>underlining</u> *(for additions) and* ~~strikethrough~~ *(for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum l to Standard 90.1-2010

Modify Section 6.5.3.1.2 as follows (I-P and SI units).

6.5.3.1.2 Motor Nameplate Horsepower. For each fan, the selected fan motor shall be no larger than the first available motor size greater than the bhp. The fan bhp must be indicated on the design documents to allow for compliance verification by the code official.

Exceptions:

a. For fans less than 6 bhp, where the first available motor larger than the bhp has a nameplate rating within 50% of the bhp, the next larger nameplate motor size may be selected.

b. For fans 6 bhp and larger, where the first available motor larger than the bhp has a nameplate rating within 30% of the bhp, the next larger nameplate motor size may be selected.

<u>c. Systems complying with Section 6.5.3.1.1, Option 1.</u>

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FOREWORD

This addendum adds power density and control requirements to capture additional savings, adds a needed exemption for practical application, includes submittal requirements, and changes control credits to apply only to lamps in multilamp fixtures that are controlled. Specifically. this addendum:

- *Adds specific exterior control requirements to exterior lighting alterations (daylight shutoff and façade/landscape after-hours shutoff).*
- *Adds the submittal section of the lighting section to the compliance path to ensure that it is clear that compliance with Section 9.7 on submittals is mandatory.*
- *Adds all nonhuman life forms to the exceptions because, like plants, the lighting needs for humans are not sufficient for the growth and maintenance of animals, which often require different light levels and lighting spectrum.*
- *Adds the exterior loading area type to Table 9.4.3b because loading docks are specifically listed as being in the scope of Standard 90.1 (Section 9.1.1b), but they are not listed in Table 9.4.3b and therefore have no power allowance associated with them.*
- *Modifies the application of control credits to the appropriate lighting and the specific lighting that is actually controlled as follows:*
    - *The lighting control credits are applied typically to general lighting and need to be in their own section because the current location's text (Section 9.6.2) refers to nongeneral lighting applications.*
    - *Current Standard 90.1-2010 language indicates that additional lighting power (lighting control credit) is calculated by multiplying the control factor by the controlled luminaire wattage. However, if only a fraction of the lamps in a luminaire are covered, this interpretation would allow one to take credit for the all of the watts in the luminaire, including the uncontrolled portion wattage. As an example, one could control only a couple of lamps in a 16 ft long pendant but under the current language of the standard, the entire wattage of the pendant would be able to be multiplied by the control factor. This addendum fixes this problem and has the control factor multiplied by the controlled wattage to determine the additional lighting power available for compliance.*

***Note:** In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum m to Standard 90.1-2010

Modify the following sections (I-P and SI units).

9.1.2 Lighting Alterations. ~~The *alteration* of lighting *systems* in any building space or exterior area shall comply with the *lighting power density (LPD)* requirements of Section 9 applicable to that *space* or area and the *automatic* shutoff requirements of 9.4.1.1~~.

<u>For the *alteration* of any lighting system in an interior *space*, that *space* shall comply with the *lighting power density (LPD)* requirements of Section 9 applicable to that *space* and the *automatic* shutoff requirements of 9.4.1.1. For the *alteration* of any lighting system in an exterior building application, that lighting system shall comply with the *lighting power density (LPD)* requirements of Section 9 applicable to the area illuminated by that lighting system and the applicable control requirements of 9.4.1.7a and 9.4.1.7b.</u> Such *alterations* shall include all *luminaires* that are added, replaced or removed. This requirement shall also be met for *alterations* that involve only the replacement of *lamps* plus *ballasts*. *Alterations* do not include routine maintenance or repair situations.

Exception: *Alterations* that involve less than 10% of the connected lighting load in a *space* or area need not comply with these requirements provided that such *alterations* do not increase the installed *LPD*.

…

9.2.1 Lighting systems and equipment shall comply with Section 9.1, General; Section 9.4, Mandatory Provisions<u>,</u> <u>Section 9.7, Submittals</u>; and the prescriptive requirements of either:

a. Section 9.5, Building Area Method; or
b. Section 9.6, Space-by-Space Method.

…

Modify the following in Section 9.2.2.3 (I-P and SI units).

…

f. <u>Lighting specifically designed for the life support of non-human life forms.</u> ~~Lighting for plant growth or maintenance.~~

…

Add the following to Table 9.4.3b (I-P units).

TABLE 9.4.3B Individual Lighting Power Allowances for Building Exteriors

	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
...					
Tradable Surfaces (*LPD*s for uncovered parking areas, building grounds, building entrances ~~and exits~~, exits and loading docks, canopies and overhangs, and outdoor sales areas may be traded.)					
...					
Building Entrances ~~and Exits~~, Exits and Loading Docks					
Main entries	No allowance	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
Other doors	No allowance	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
Entry canopies	No allowance	0.25 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
Loading docks	No allowance	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2	0.5 W/ft^2
...					

Add the following to Table 9.4.3b (SI units).

TABLE 9.4.3B Individual Lighting Power Allowances for Building Exteriors

	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4
...					
Tradable Surfaces (*LPD*s for uncovered parking areas, building grounds, building entrances ~~and exits~~, exits and loading docks, canopies and overhangs, and outdoor sales areas may be traded.)					
...					
Building Entrances ~~and Exits~~, Exits and Loading Docks					
Main entries	No allowance	66 W/linear meter of door width	66 W/linear meter of door width	98 W/linear meter of door width	98 W/linear meter of door width
Other doors	No allowance	66 W/linear meter of door width	66 W/linear meter of door width	66 W/linear meter of door width	66 W/linear meter of door width
Entry canopies	No allowance	2.7 W/m^2	2.7 W/m^2	4.3 W/m^2	4.3 W/m^2
Loading docks	No allowance	5.4 W/m^2	5.4 W/m^2	5.4 W/m^2	5.4 W/m^2
...					

Modify Section 9.6.2 and renumber the following section and table as follows (I-P and SI units).

9.6.2 Additional Interior Lighting Power. When using the Space-by-Space Method, an increase in the interior lighting power allowance is allowed for specific lighting functions. Additional power shall be allowed only if the specified lighting is installed and automatically controlled, separately from the general lighting, to be turned off during nonbusiness hours. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose, unless otherwise indicated. An increase in the interior lighting power allowance is permitted in the following cases:

a. …

b. …

~~c. For space types identified in Table 9.6.2, when additional controls are used as indicated, provided that all mandatory controls are used according to Section 9.4, the additional lighting power, to be used anywhere in the building, is calculated as follows:~~

9.6.3 Additional Interior Lighting Power Using Nonmandatory Controls. An additional lighting power allowance shall be permitted for space types with nonmandatory controls installed as identified in Table 9.6.3 when all mandatory controls are used according to Section 9.4. This allowance is added to the *interior lighting power allowance* and is calculated as follows:

Additional Interior Lighting Power Allowance =
Lighting Power Under Control × Control Factor

where

Lighting Power Under Control	=	the total input watts of all lamps being controlled using the control method indicated ~~the total wattage of all lighting fixtures that are controlled in the given *space* using the control method indicated~~
Control Factor	=	the value given in Table 9.6.~~2~~3 for the corresponding space type and control method.

9.6.4~~3~~ Room Geometry Adjustment.

TABLE 9.6.3~~2~~ Control Factors Used in Calculating Additional Interior Lighting Power Allowance

Modify footnote 2 in renumbered Table 9.6.3 as follows (I-P and SI units).

TABLE 9.6.3~~2~~ Control Factors Used in Calculating Additional Interior Lighting Power Allowance

…

2. Control factor is limited to ~~the wattage of~~ workstation-specific luminaires in partitioned single occupant workspaces contained within an open office environment (i.e. direct-indirect luminaires with separately controlled downlight and uplight components, with the downward component providing illumination to a single occupant in an open plan workstation). Within 30 minutes of the occupant leaving the space, the downward component shall continuously dim to off over a minimum of 2 minutes. Upon the occupant entering the space, the downward component shall turn on at the minimum level and continuously raise the illumination to a preset level over a minimum of 30 seconds. The uplight component of workstation specific luminaire shall comply with section 9.4.1.1 (automatic shutoff).

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FOREWORD

The intent of this addendum is to clarify that the total lumens per watt for the entire elevator cab is required to meet the efficiency requirement but that it is not required that each individual light source must comply.

Note: *In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum n to Standard 90.1-2010

Revise Section 10.4.3 as follows (I-P and SI units).

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

10.4.3.1 Lighting. ~~All cab lighting systems shall have efficacy of not less than 35 lumens per Watt.~~ For the luminaires in each elevator cab, not including signals and displays, the sum of the lumens divided by the sum of the watts (as described in Section 9.1.4) shall be no less than 35 lumens per watt.

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FOREWORD

This addendum updates the ASHRAE dynamic glazing definition to match the National Fenestration Rating Council (NFRC) dynamic glazing definition.

This addendum clarifies how required energy indices shall be provided for fenestration and door products.

This addendum updates fenestration product (windows, doors, skylights) labeling to the 2010 editions of the NFRC publications.

***Note:** In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum q to Standard 90.1-2010

Modify Section 3 as follows (I-P and SI units).

dynamic glazing: any ~~*fenestration*~~ ~~product~~ glazing system/glazing infill that has the fully reversible ability to change its performance properties, including *U-factor*, *SHGC*, or *VT*. This includes, but is not limited to, shading systems between the glazing layers and chromogenic glazing.

Modify Section 5 as follows (I-P and SI units).

5.8.2.2 Labeling of Fenestration and Door Products. All manufactured and site-built *fenestration* and door products shall ~~have a permanent nameplate, installed~~ be *labeled*, or a signed and dated certificate shall be provided, by the *manufacturer*, listing the U-factor, SHGC, VT, and air leakage rate~~, and where required by the Exception to 5.5.4.4.2, Visible Transmittance (VT)~~.

Exception: Doors with less than 25% glazing are not required to list SHGC and VT. ~~When the *fenestration* product does not have such nameplate, the installer or supplier of such *fenestration* shall provide a signed and dated certification for the installed fenestration listing the U-factor, SHGC, and the air leakage rate.~~

~~**5.8.2.3 Labeling of Doors.** The *U-factor* and the air leakage rate for all manufactured *doors* installed between *conditioned space*, *semi-heated space*, *unconditioned space*, and exterior *space* shall be identified on a permanent nameplate installed on the product by the *manufacturer*.~~

~~**Exception:** When doors do not have such a nameplate, the installer or supplier of any such doors shall provide a signed and dated certification for the installed doors listing the *U-factor* and the air leakage rate.~~

Modify Section 12 as follows (I-P and SI units).

National Fenestration Rating Council,
~~**1300 Spring Street, Suite 500, Silver Springs, MD 20910**~~
6305 Ivy Lane, Suite 140, Greenbelt, MD 20770-6323

NFRC 100-~~2004~~2010	Procedure for Determining Fenestration Product U-Factors
NFRC 200-~~2004~~2010	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence
NFRC 300-~~2004~~2010	~~Standard~~ Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems
NFRC 400-~~2004~~2010	Procedure for Determining Fenestration Product Air Leakage

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FOREWORD

The requirement for consistent temperature and humidity control setpoints and schedules listed in Table G3.1, under "Proposed Building Performance, Design Model," could be interpreted to conflict with the exception listed in Table G3.1 under "Baseline Building Performance, Schedules."

In a formal interpretation of ASHRAE 90.1-2004 dated June 21, 2008, the committee noted that it would work to make changes to the standard to clarify the requirements for temperature and humidity control with regard to the baseline and proposed buildings. This addendum clarifies the intent of the committee and relocates all wording related to thermostat and humidity schedules to the schedules section of Table G3.1 for greater ease of use.

In addition, direction is provided regarding setpoint and schedules requirements for modeling systems that provide occupant thermal comfort via means other than directly controlling the air dry-bulb and wet-bulb temperature (i.e., radiant cooling/heating, elevated air speed, etc.).

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum r to Standard 90.1-2010

Modify Table G3.1 as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No. Proposed Building Performance	Baseline Building Performance
1. Design Model	
a. The simulation model of the proposed design shall be consistent with the design documents, including proper accounting of fenestration and opaque envelope types and areas; interior lighting power and controls; HVAC system types, sizes, and controls; and service water heating systems and controls. All end-use load components within and associated with the building shall be modeled, including, but not limited to, exhaust fans, parking garage ventilation fans, snow-melt and freeze-protection equipment, facade lighting, swimming pool heaters and pumps, elevators and escalators, refrigeration, and cooking. Where the simulation program does not specifically model the functionality of the installed system, spreadsheets or other documentation of the assumptions shall be used to generate the power demand and operating schedule of the systems. b. All conditioned spaces in the proposed design shall be simulated as being both heated and cooled even if no heating or cooling system is to be installed. ~~Temperature and humidity control setpoints and schedules as well as temperature control throttling range shall be the same for proposed and baseline building designs.~~ **Exception:** Spaces using Baseline System types 9 and 10 shall not be simulated with mechanical cooling. c. When the performance rating method is applied to buildings in which energy-related features have not yet been designed (e.g., a lighting system), those yet-to-be-designed features shall be described in the proposed design exactly as they are defined in the baseline building design. Where the space classification for a space is not known, the space shall be categorized as an office space.	The baseline building design shall be modeled with the same number of floors and identical conditioned floor area as the proposed design.
[. . .]	[. . .]
4. Schedules	
Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation shall be used. The schedules shall be typical of the proposed building type as determined by the designer and approved by the rating authority. **Temperature and Humidity Schedules.** Temperature and humidity control setpoints and schedules as well as temperature control throttling range shall be the same for proposed and baseline building designs. **HVAC Fan Schedules**. Schedules for HVAC fans that provide outdoor air for ventilation shall run continuously whenever spaces are occupied and shall be cycled on and off to meet heating and cooling loads during unoccupied hours. **Exceptions:** a. Where no heating and/or cooling system is to be installed and a heating or cooling system is being simulated only to meet the requirements described in this table, heating and/or cooling system fans shall not be simulated as running continuously during occupied hours but shall be cycled on and off to meet heating and cooling loads during all hours. b. HVAC fans shall remain on during occupied and unoccupied hours in spaces that have health and safety mandated minimum ventilation requirements during unoccupied hours.	Same as Proposed Design **Exception:** a. Setpoints and schedules for HVAC systems that automatically provide occupant thermal comfort via means other than directly controlling the air dry-bulb and wet-bulb temperature may be allowed to differ provided that equivalent levels of occupant thermal comfort are demonstrated via the methodology in Section 5.2.3 of ASHRAE Standard 55, "Elevated Air Speed," or Appendix D of Standard 55, "Computer Program for Calculation of PMV-PPD." b. Schedules may be allowed to differ between proposed design and baseline building design when necessary to model nonstandard efficiency measures, provided that the revised schedules have the approval of the rating authority. Measures that may warrant use of different schedules include, but are not limited to, automatic lighting controls, automatic natural ventilation controls, automatic demand control ventilation controls, and automatic controls that reduce service water heating loads. In no case shall schedules differ where the controls are manual (e.g., manual operation of light switches or manual operation of windows).

Add the following reference to Section 12 (I-P and SI units).

Reference	Title
ASHRAE **1791 Tullie Circle, NE, Atlanta, GA 30329**	
ANSI/ASHRAE Standard 55-2010	Thermal Environmental Conditions for Human Occupancy

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FOREWORD

Fan power limits have been in Standard 90.1 for some time. These place restrictions on the design of systems and the amount of fan energy utilized. However the standard has not had a requirement for a minimum fan efficiency. A fan efficiency metric was developed in cooperation with TC 5.1 by which fans are classified based on fan efficiency grades. This system is designated in AMCA 205-12 on which this addendum is based.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum u to Standard 90.1-2010

Revise Section 3.2 as follows for I-P and SI units.

fan efficiency grade (FEG): the fan efficiency without consideration of drives, as defined in AMCA 205.

power roof/wall ventilators (PRV): a fan consisting of a centrifugal or axial impeller with an integral driver in a weather-resistant housing and with a base designed to fit, usually by means of a curb, over a wall or roof opening.

Revise Section 6.5.3.1 as follows for I-P and SI units.

6.5.3.1 Fan System Power and Efficiency ~~Limitation~~

...

6.5.3.1.3 Fan Efficiency. Fans shall have a *fan efficiency grade* (FEG) of 67 or higher based on manufacturers' certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

Exceptions:

a. Single fans with a motor *nameplate horsepower* of 5 hp (4 kW) or less.
b. Multiple fans in series or parallel (e.g., fan arrays) that have a combined motor *nameplate horsepower* of 5 hp (4 kW) or less and are operated as the functional equivalent of a single fan.
c. Fans that are part of equipment listed under Section 6.4.1.1, "Minimum Equipment Efficiencies—Listed Equipment—Standard Rating and Operating Conditions."
d. Fans included in equipment bearing a third-party-certified seal for air or energy performance of the equipment package.
e. Powered wall/roof ventilators (PRV).
f. Fans outside the scope of AMCA 205.
g. Fans that are intended to only operate during emergency conditions.

Revise Section 12, Normative References, as follows for I-P and SI units.

AMCA 205-12 Energy Efficiency Classification for Fans.

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FOREWORD

A continuous maintenance proposal was submitted to clarify the credit for on-site renewable energy and site-recovered energy in Section 11 and Appendix G. We agree that clarification was warranted.

Definitions for on-site renewable energy and purchased energy have been added along with clearer guidance on the determination of applicable credits in Section 11 and Appendix G.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum w to Standard 90.1-2010

Modify the standard as follows (I-P and SI units).

3.2 Definitions

on-site renewable energy: energy generated from renewable sources produced at the building site.-

purchased energy: energy or power purchased for consumption and delivered to the building site.

Add the following under Section 11.1.5, "Documentation Requirements."

e. The reduction in design energy cost associated with on-site renewable energy.

Replace the current text of Section 11.2.3 with the following.

11.2.3 Renewable, Recovered, and Purchased Energy

11.2.3.1 On-Site Renewable Energy and Site Recovered Energy. Site-recovered energy shall not be considered purchased energy and shall be subtracted from the proposed design energy consumption prior to calculating the design energy cost. On-site renewable energy, generated by systems included on the building permit, that is used directly by the building shall be subtracted from the proposed design energy consumption prior to calculating the design energy cost. The reduction in design energy cost associated with on-site renewable energy shall be no more than 5% of the calculated energy-cost budget.

11.2.3.2 Annual Energy Costs. The design energy cost and energy-cost budget shall be determined using rates for purchased energy (such as electricity, gas, oil, propane, steam, and chilled water) that are approved by the adopting authority. Where on-site renewable energy or site-recovered energy is used, the budget building design shall be based on the energy source used as the backup energy source, or electricity if no backup energy source has been specified.

Add the following under Section G1.4, "Documentation Requirements."

p. The reduction in proposed building performance associated with on-site renewable energy.

Replace the current text of Section G.2.4 with the following.

G2.4 Renewable, Recovered, and Purchased Energy

G2.4.1 On-Site Renewable Energy and Site-Recovered Energy. Site-recovered energy shall not be considered purchased energy and shall be subtracted from the proposed design energy consumption prior to calculating the proposed building performance. On-site renewable energy generated by systems included on the building permit that is used by the building shall be subtracted from the proposed design energy consumption prior to calculating the proposed building performance.

G2.4.2 Annual Energy Costs. The design energy cost and baseline energy cost shall be determined using either actual rates for purchased energy or state average energy prices published by DOE's Energy Information Administration (EIA) for commercial building customers, but rates from different sources may not be mixed in the same project. Where on-site renewable energy or site-recovered energy is used, the baseline building design shall be based on the energy source used as the backup energy source or electricity if no backup energy source has been specified.

Note: The above provision allows users to gain credit for features that yield load management benefits. Where such features are not present, users can simply use state average unit prices from EIA, which are updated annually and are readily available on EIA's website.

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FOREWORD

Currently, Section 6 has various requirements for control logic that apply only to systems that have direct digital controls (DDC). See, for example, Sections 6.4.3.9 Exception b, 6.5.3.2.3, 6.5.3.3, and 6.5.4.1. But there are no subsections that mandate that DDC be installed. In the first public review of Addendum aa, DDC was mandated in many of the above-referenced subsections with qualifications such as the quantity of zones. But public review comments pointed out that in some cases this would inadvertently mandate that DDC be retrofitted on existing systems and zones, often at great expense. For example, to convert pneumatic VAV zones to DDC is very expensive and not always cost effective.

This revised version of Addendum aa addresses the issue more broadly by mandating DDC for certain applications in both new buildings and retrofits where, in the SSPC's opinion, it will be cost effective. It also defines the minimum capability of mandated DDC systems. This is needed because almost any modern microprocessor-based controller qualifies as DDC by the current definition. But to fully benefit from DDC, capabilities such as transferring information among controllers, collecting and displaying trends, etc. are required.

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Addendum aa to Standard 90.1-2010

Add the following to Section 3.3 (I-P and SI units).

DDC direct digital control

Add the following Section 6.4.3.11 and renumber susbsequent sections accordingly (I-P and SI units).

6.4.3.11 Direct Digital Control (DDC) Requirements. Direct digital control shall be required as follows.

6.4.3.11.1 DDC Applications. DDC shall be provided in the applications and qualifications listed in Table 6.4.3.11.1.

Exception: DDC is not required for systems using the simplified approach to compliance in accordance with Section 6.3.1.

6.4.3.11.2 DDC Controls. Where DDC is required by Section 6.4.3.11.1, the DDC system shall be capable of all of the following, as required, to provide the control logic required in Section 6.5:

a. Monitor zone and system demand for fan pressure, pump pressure, heating, and cooling.
b. Transfer zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers.
c. Automatically detect those zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator.
d. Readily allow operator removal of zone(s) from the reset algorithm.

6.4.3.11.3 DDC Display. Where DDC is required by Section 6.4.3.11.1 for new buildings, the DDC system shall be capable of trending and graphically displaying input and output points.

TABLE 6.4.3.11.1 DDC Applications and Qualifications

Building Status	Application	Qualifications
New building	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with fan system bhp of 10 hp (7.45 kW) and larger
New building	Chilled-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h (87.9 kW) and larger
New building	Hot-water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h (87.9 kW) and larger
Alteration or addition	Zone terminal unit such as VAV box	Where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC
Alteration or addition	Air-handling system or fan coil	Where existing air-handling system(s) and fan-coil(s) served by the same chilled- or hot-water plant have DDC
Alteration or addition	New air-handling system and all new zones served by the system	Individual systems with fan system bhp of 10 hp(7.45 kW) and larger and supplying more than three zones and more than 75% of zones are new
Alteration or addition	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h (87.9 kW) and larger
Alteration or addition	New or upgraded hot-water plant	Where all boilers are new and plant design heating capacity is 300,000 Btu/h (87.9 kW) and larger

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FOREWORD

This addendum updates referenced standards for ARI 340/360 and ARI 1230 in various provisions covering mechanical systems in Standard 90.1-2010.

Note: *In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum ad to Standard 90.1-2010

Revise Section 12 as follows (I-P and SI units).

12. NORMATIVE REFERENCES

Reference	Title
Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201	
AHRI 340/360-2007 with Addenda 1 and 2	*Performance Rating of Commercial and Industrial Unitary Air Air-Conditioning and Heat Pump Equipment*
AHRI 1230-2010 with Addendum 1	*Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air-Conditioning and Heat Pump Equipment*

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FOREWORD

This proposal is update referenced standards for AHRI 210/240 and AHRI 550/590 in various provisions covering mechanical systems in ASHRAE/IES Standard 90.1-2010.

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Addendum ae to Standard 90.1-2010

Revise Section 12 as follows (I-P and SI units)

Reference	Title
Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201	
AHRI 210/240-2008 with Addendum 1 and 2	Unitary Air Conditioning and Air-Source Heat Pump Equipment
AHRI 550/590-2011	Water-Chilling Packages Using the Vapor Compression Cycle

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FOREWORD

This addendum covers two changes to Section 6 of Standard 90.1, incorporating open-circuit cooling tower flow turndown and fan control for multifan heat rejection installations as follows:

- *The addition of a flow turndown requirement to the Standard will require the use of cooling towers capable of handling modulation of condenser water flow as a means to save energy. Manufacturers would need to design and supply spray water distribution systems, either gravity flow or pressurized, that will function properly at a reduced flow over the tower. The 50% flow turndown ratio was established to minimize the potential for scaling of the heat transfer surface in the tower, which can reduce the capacity of the tower and consequently lead to higher energy use. The 50% turndown ratio also corresponds with the latest proposal for a similar flow turndown requirement in California Title 24.*
- *As virtually all heat rejection equipment utilize VSDs on the 7.5 HP fans and above, a requirement to operate the maximum number of fans in a multi-fan installation to minimize energy for a given duty has been added as 6.5.5.2.2. All fans should be operated in tandem at the same fan speed as this control sequence for multi-fan installations is more energy efficient than on/off or sequenced fan operation. A note that the minimum fan speed must comply with the minimum allowable speed of the fan drive system per the heat rejection device manufacturer's recommendations was also added.*

Two other changes were also made.

- *Section 6.5.5.1 was revised to include dry coolers as an example since they are common devices used for heat rejection and to clarify the two types of cooling towers referenced in this section (open-circuit and closed-circuit).*
- *Section 6.5.5.2.1 was revised to eliminate exception d. as most heat transfer devices utilize VSDs due to the many benefits and declining costs of VSDs. This exception would also conflict with the fan speed requirement in 6.5.5.2.2 for multi-cell heat rejection devices.*

Note that this change to the Standard is supported by the Standards Subcommittee of TC08.06, the ASHRAE technical committee for Cooling Tower and Evaporative Condensers.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum af to Standard 90.1-2010

Revise the standard as follows for I-P units.

6.5.5 Heat Rejection Equipment

6.5.5.1 General. Section 6.5.5 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, <u>dry coolers,</u> open-<u>circuit</u> cooling towers, closed-circuit cooling towers, and evaporative condensers.

Exception: Heat rejection devices whose energy usage is included in the equipment efficiency ratings listed in Tables 6.8.1A through 6.8.1D.

6.5.5.2 Fan Speed Control

<u>**6.5.5.2.1**</u> Each fan powered by a motor of 7.5 hp or larger shall have the capability to operate ~~that fan~~ at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

Exceptions:

a. Condenser fans serving multiple refrigerant circuits.
b. Condenser fans serving flooded condensers.
c. Installations located in climate zones 1 and 2.
~~d. Up to one-third of the fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement.~~

<u>**6.5.5.2.2** Multiple cell heat rejection equipment with variable speed fan drives shall</u>

<u>a. operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and</u>
<u>b. control all fans to the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer's recommendations.</u>

6.5.5.3 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1100 gpm or greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 6.8.1G.

Exception: Centrifugal open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation.

<u>**6.5.5.4 Tower Flow Turndown.** Open-circuit cooling towers used on water cooled chiller systems that are config-</u>

ured with multiple or variable speed condenser water pumps shall be designed so that all open-circuit cooling tower cells can be run in parallel with the larger of

a. the flow that is produced by the smallest pump at its minimum expected flow rate or
b. 50% of the design flow for the cell.

Revise the standard as follows for SI units.

6.5.5 Heat Rejection Equipment

6.5.5.1 General. Section 6.5.5 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers, and evaporative condensers.

Exception: Heat rejection devices whose energy usage is included in the equipment efficiency ratings listed in Tables 6.8.1A through 6.8.1D.

6.5.5.2 Fan Speed Control

6.5.5.2.1 Each fan powered by a motor of 5.6 kW or larger shall have the capability to operate ~~that fan~~ at two-thirds of full speed or less and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

Exceptions:

a. Condenser fans serving multiple refrigerant circuits.
b. Condenser fans serving flooded condensers.
c. Installations located in climate zones 1 and 2.
~~d. Up to one-third of the fans on a condenser or tower with multiple fans, where the lead fans comply with the speed control requirement.~~

6.5.5.2.2 Multiple cell heat rejection equipment with variable speed fan drives shall

a. operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and
b. control all fans to the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. Minimum fan speed shall comply with the minimum allowable speed of the fan drive system per the manufacturer's recommendations.

6.5.5.3 Limitation on Centrifugal Fan Open-Circuit Cooling Towers. Centrifugal fan open-circuit cooling towers with a combined rated capacity of 69 L/s or greater at 35°C condenser water return, 29°C condenser water supply, and 24°C outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 6.8.1G.

Exception: Centrifugal open-circuit cooling towers that are ducted (inlet or discharge) or require external sound attenuation.

6.5.5.4 Tower Flow Turndown. Open-circuit cooling towers used on water cooled chiller systems that are configured with multiple condenser water pumps shall be designed so that all open-circuit cooling tower cells can be run in parallel with the larger of

a. the flow that is produced by the smallest pump or
b. 50% of the design flow for the cell.

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FOREWORD

This addendum establishes guidelines for claiming energy savings that result from reduced infiltration in Appendix G. The proposed change allows credit for buildings that complete envelope pressurization testing in accordance with ASTM 7979. The proposal establishes a baseline air leakage rate of 0.40 cfm/ft^2 (2.03 L/s·m^2) at 0.3 in. wc (75 Pa) pressure differential.

The proposed addendum also includes language to clarify how to convert air leakage rate at a 0.3 in. wc (75 Pa) pressure differential to units suitable for use in the most common energy modeling software tools. The conversion of measured air leakage at 0.3 in. wc (75 Pa) pressure differential to units suitable for energy models is a complex calculation that would be onerous for most project design teams trying to design low-energy-use buildings. A simplified method for this conversion has been proposed based on research conducted by Pacific Northwest National Labs. The approach is based on published, peer-reviewed research and provides a sensible solution to a complex calculation. The energy savings achievable under this new credit will be small relative to the whole-building annual energy cost because of the new air-barrier requirements in ASHRAE Standard 90.1-2010.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ag to Standard 90.1-2010

Revise Table G3.1 as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
	[. . .]	[. . .]
5.	**Building Envelope**	
a.	All components of the building envelope in the proposed design shall be modeled as shown on architectural drawings or as built for existing building envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. ~~a.~~1. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages, roof parapet) shall be separately modeled using either of the following techniques: ~~1.~~(a) Separate model of each of these assemblies within the energy simulation model. ~~2.~~(b) Separate calculation of the U-factor for each of these assemblies. The U-factors of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average U-factor is modeled within the energy simulation model. Any other envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described provided that it is similar to an assembly being modeled. If not separately described, the area of an envelope assembly shall be added to the area of an assembly of that same type with the same orientation and thermal properties. ~~b.~~2. Exterior surfaces whose azimuth orientation and tilt differ by less than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. ~~c.~~3. The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.1(a). Where aged test data is unavailable, the roof surface may be modeled with a reflectance of 0.30 and a thermal emittance of 0.90. ~~d.~~4. Manual fenestration shading devices such as blinds or shades shall be modeled or not modeled, the same as in the baseline. Automatically controlled fenestration shades or blinds shall be modeled. Permanent shading devices such as fins, overhangs, and light shelves shall be modeled. ~~e.~~5. Automatically controlled dynamic glazing may be modeled. Manually controlled dynamic glazing shall use the average of the minimum and maximum SHGC and VT.	Equivalent dimensions shall be assumed for each exterior envelope component type as in the proposed design; i.e., the total gross area of exterior walls shall be the same in the proposed and baseline building designs. The same shall be true for the areas of roofs, floors, and doors, and the exposed perimeters of concrete slabs on grade shall also be the same in the proposed and baseline building designs. The following additional requirements shall apply to the modeling of the baseline building design: a. **Orientation.** The baseline building performance shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. **Exceptions:** 1. If it can be demonstrated to the satisfaction of the Program Evaluator that the building orientation is dictated by site considerations. 2. Buildings where the vertical fenestration area on each orientation varies by less than 5%. b. **Opaque Assemblies.** Opaque assemblies used for new buildings, existing buildings, or additions shall conform with the following common, lightweight assembly types and shall match the appropriate assembly maximum U-factors in Tables 5.5-1 through 5.5-8: • Roofs—Insulation entirely above deck • Above-grade walls—Steel-framed • Floors—Steel-joist • Opaque door types shall match the proposed design and conform to the U-factor requirements from the same tables. • Slab-on-grade floors shall match the F-factor for unheated slabs from the same tables. c. **Vertical Fenestration Areas.** Vertical fenestration areas for new buildings and additions shall equal that in the proposed design or the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is smaller, and shall be distributed on each face of the building in the same proportions in the proposed design. The fenestration area for an existing building shall equal the existing fenestration area prior to the proposed work and shall be distributed on each face of the building in the same proportions as the existing building. For portions of those tables where there are no SHGC requirements, the SHGC shall be equal to that determined in accordance with Section C3.5. The VT shall be equal to that determined in accordance with Section C3.5. d. **Vertical Fenestration Assemblies.** Fenestration for new buildings, existing buildings, and additions shall comply with the following: • Fenestration U-factors shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. • Fenestration SHGCs shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. • All vertical fenestration shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled. • Manual window shading devices such as blinds or shades are not required to be modeled. e. **Skylights and Glazed Smoke Vents.** Skylight area shall be equal to that in the proposed building design or the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is smaller. If the skylight area of the proposed building design is greater than area the maximum allowed in Tables 5.5-1 through 5.5-8, baseline skylight area shall be decreased by an identical percentage in all roof components in which skylights are located to reach the maximum allowed in Tables 5.5-1 through 5.5-8. Skylight orientation and tilt shall be the same as in the proposed building design. Skylight U-factor and SHGC properties shall match the appropriate requirements in s 5.5-1 through 5.5-8. f. **Roof Solar Reflectance and Thermal Emittance.** The exterior roof surfaces shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.1.1(a). All other roofs, including roofs exempted from the requirements in Section 5.5.3.1.1, shall be modeled using a solar reflectance of 0.30 and a thermal emittance of 0.90.
b.	Infiltration shall be modeled using the same methodology, air leakage rate, and adjustments for weather and building operation in both the proposed design and the baseline design. These adjustments shall be made for each simulation time step and must account for but not be limited to weather conditions and HVAC system operation, including strategies that are intended to positively pressurize the building. The air leakage rate of the building envelope (I_{75Pa}) at a fixed building pressure differential of 0.3 in. wc (75 Pa) shall be 0.4 cfm/ft^2 (2.03 L/s.m^2). The air leakage rate of the building envelope shall be converted to appropriate units for the simulation program using one of the methods in Section G3.1.1.4. **Exception:** When whole-building air leakage testing, in accordance with ASTM E779, is specified during design and completed after construction, the proposed design air leakage rate of the building envelope shall be as measured.	

Revise Section G3.1.1.4 (I-P and SI units).

G3.1.1.4 Modeling Building Envelope Infiltration. The air leakage rate of the building envelope (I_{75Pa}) at a pressure differential of 0.3 in. wc (75 Pa) shall be converted to appropriate units for the simulation program using one of the following formulas:

For methods describing infiltration as a function of floor area,

$$I_{FLR} = 0.112 \times I_{75Pa} \times S/A_{FLR}$$

For methods describing infiltration as a function of exterior wall area,

$$I_{EW} = 0.112 \times I_{75Pa} \times S/A_{EW}$$

When using the measured air leakage rate of the building envelope at a pressure differential of 0.3 in. wc (75 Pa) for the proposed design, the air leakage rate shall be calculated as follows:

$$I_{75Pa} = Q/S$$

where

I_{75Pa} = air leakage rate of the building envelope expressed in cfm/ft^2 (L/s·m^2) at a fixed building pressure differential of 0.3 in. wc, or 1.57 psf (75 Pa)

Q = volume of air in cfm (L/s) flowing through the whole-building envelope when subjected to an indoor/outdoor pressure differential of 0.3 in. wc, or 1.57 psf (75 Pa), in accordance with ASTM E 779

S = total area of the envelope air pressure boundary, including the lowest floor, any below- or above-grade walls, and roof (or ceiling) (including windows and skylights), separating the interior conditioned space from the unconditioned environment measured, ft^2 (m2)

I_{FLR} = adjusted air leakage rate of the building envelope at a reference wind speed of 10 mph (4.47 m/s) and the above ground exterior wall area

A_{FLR} = total gross floor area, ft^2 (m^2)

I_{EW} = adjusted air leakage rate of the building envelope at a reference wind speed of 10 mph (4.47 m/s) and the above ground exterior wall area

A_{EW} = total above-grade exterior wall area, ft^2 (m^2)

Exception: A multizone airflow model alternate method to model building envelope infiltration may be used provided the following criteria are met:

a. If the calculations are made independently of the energy simulation program, the proposed method must comply with Section G2.5, "Exceptional Calculation Method."

b. The method for converting the air infiltration rate of the building envelope at 0.3 in. wc, or 1.57 psf (75 Pa), to the appropriate units for the simulation program is fully documented and submitted to the rating authority for approval.

Revise Section 12 as follows (I-P and SI units).

Reference	Title
[. . .]	
ASTM International, **100 Barr Harbor Dr., West Conshohocken, PA 19428-2959**	
[. . .]	
ASTM E779-10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
[. . .]	
[. . .]	

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FOREWORD

Buildings located in humid climates may require dehumidification and reheat of supply air to maintain space dry-bulb temperatures even when ventilation requirements may be no more than local code and/or Standard 62.1.

Appendix G baseline building design systems 3 through 8 are "single-path" airflow systems, and unless the requirements for exhaust air energy recovery (Section 6.5.6.1) are met, the baseline building design system may be required to reheat the supply airstream given the dehumidification load. Because space dehumidification setpoints must be the same between the baseline building design and proposed design, humid climates may result in the baseline building design system having to substantially subcool the supply airstream and, in turn, reheat to maintain the space supply air dry-bulb setpoint. In some scenarios this may result in considerable energy consumption for the baseline building design.

The new Exception b to Section G3.1.2.9.1 allows the baseline building design supply air to be sized based on the same humidity ratio difference of the proposed design. New Section G3.1.3.18 requires the baseline building design to count only 25% of the total energy used to reheat the supply airstream. The assumption is that 75% of the total energy used to reheat in the baseline building design comes from a recovered source (i.e., condenser heat recovery or exhaust air energy recovery, etc.). By comparison, Section G3.1.3.18 requires design teams to seriously consider limiting or eliminating reheat (by using dedicated outdoor air units, condenser heat recovery, or exhaust air energy recovery, etc.) in the proposed design, because the baseline building design gets 75% of its total reheat energy from a recovered source.

Note: *In this addendum, changes to the current standard are indicated in the text by* <u>*underlining*</u> *(for additions) and* ~~*strikethrough*~~ *(for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum ah to Standard 90.1-2010

Add the following acronym to Section 3.3 (I-P units).

<u>gr</u> <u>grains of moisture per pound of dry air</u>

Add the following acronym to Section 3.3 (SI units).

<u>gr</u> <u>grains of moisture per kilogram of dry air</u>

Revise Section G3 as follows (I-P units).

G3.1.2.9 Design Air Flow Rates.

G3.1.2.9.1 Baseline System Types 1 through 8. System design supply air flow rates for the *baseline building design* shall be based on a supply-air-to-room-air temperature difference of 20°F or the minimum outdoor air flow rate, or the air flow rate required to comply with applicable codes or accreditation standards, whichever is greater. If return or relief fans are specified in the *proposed design*, the *baseline building design* shall also be modeled with fans serving the same functions and sized for the *baseline* system supply fan air quantity less the minimum *outdoor air*, or 90% of the supply fan air quantity, whichever is larger.

Exception<u>s</u>:

a. For systems serving laboratory spaces, use a supply-air-to-room-air temperature difference of 17°F or the required ventilation air or makeup air, whichever is greater.

<u>b.</u> <u>If the *proposed design* HVAC design airflow rate based on latent loads is greater than the design airflow rate based on sensible loads, then the same supply-air-to-room-air humidity ratio difference (gr/lb) used to calculate the *proposed design* airflow shall be used to calculate design airflow rates for the *baseline building design.*</u>

...

<u>**G3.1.3.18 Dehumidification (Systems 3 through 8).** If the *proposed design* HVAC system(s) have humidistatic controls, then the *baseline building design* shall use mechanical cooling for dehumidification and shall have reheat available to avoid overcooling. When the *baseline building design* HVAC system does not comply with any of the exceptions in Section 6.5.2.3, then only 25% of the system reheat *energy* shall be included in the *baseline building performance.* The reheat type shall be the same as the system heating type.</u>

Revise Section G3 as follows (SI units).

G3.1.2.9 Design Air Flow Rates.

G3.1.2.9.1 Baseline System Types 1 through 8. System design supply air flow rates for the *baseline building design* shall be based on a supply-air-to-room-air temperature difference of ~~20°F~~ <u>11°C</u> or the minimum outdoor air flow rate, or the air flow rate required to comply with applicable codes or accreditation standards, whichever is greater. If return or relief fans are specified in the *proposed design*, the *baseline building design* shall also be modeled with fans serving the same functions and sized for the *baseline* system supply fan air quantity less the minimum *outdoor air*, or 90% of the supply fan air quantity, whichever is larger.

Exception<u>s</u>:

a. For systems serving laboratory spaces, use a supply-air-to-room-air temperature difference of ~~17°F~~ <u>9°C</u> or the required ventilation air or makeup air, whichever is greater.

<u>b.</u> <u>If the *proposed design* HVAC design airflow rate based on latent loads is greater than the design airflow rate based on sensible loads, then the same</u>

supply-air-to-room-air humidity ratio difference (gr/kg) used to calculate the *proposed design* airflow shall be used to calculate design airflow rates for the *baseline building design.*

...

G3.1.3.18 Dehumidification (Systems 3 through 8). If the *proposed design* HVAC system(s) have humidistatic controls, then the *baseline building design* shall use mechanical cooling for dehumidification and shall have reheat available to avoid overcooling. When the *baseline building design* HVAC system does not comply with any of the exceptions in Section 6.5.2.3, then only 25% of the system reheat *energy* shall be included in the *baseline building performance.* The reheat type shall be the same as the system heating type.

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FOREWORD

This addendum updates Section 11 and Appendix G to be consistent with three addenda to Standard 90.1-2007.

The changes to Section 11.3.2(b) and G3.1.2.1 are in response to Addendum m to Standard 90.1-2007, which introduced the two paths for chiller efficiency.

The new row for Table G3.1 is in response to Addendum o to Standard 90.1-2007, which added new requirements for distribution transformers.

The changes to Section G3.1.2.8 and Tables G3.1.2.6A, G3.1.2.6B, and 11.3.2D are in response to Addendum cy to Standard 90.1-2007.

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Addendum ai to Standard 90.1-2010

Revise Section 11 as follows (I-P and SI units).

11.3.2 HVAC Systems

...

b. All HVAC and service water heating equipment in the *budget building* shall be modeled at the minimum *efficiency* levels, both part load and full load, in accordance with Sections 6.4 and 7.4. Chillers shall use Path A efficiencies as shown in Table 6.8.1C.

TABLE 11.3.2D Economizer High-Limit Shutoff

Economizer Type	High-Limit Shutoff
Air	Table 6.5.1.1.3B
Water (integrated)	When its operation will no longer reduce HVAC system energy
~~Water (nonintegrated)~~	~~When its operation can no longer provide the cooling load~~

Revise Appendix G as follows (I-P and SI units).

G3.1.2.1 Equipment Efficiencies. All HVAC equipment in the *baseline building design* shall be modeled at the minimum *efficiency* levels, both part load and full load, in accordance with Section 6.4. Where *efficiency* ratings, such as IEER and ICOP, include fan energy, the descriptor shall be broken down into its components so that supply fan energy can be modeled separately. Chillers shall use Path A efficiencies as shown in Table 6.8.1C.

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

Proposed Building Performance	Baseline Building Performance
15. Distribution Transformers	
Low-voltage dry-type distribution transformers shall be modeled if the transformers in the proposed design exceed the efficiency required in Table 8.1.	Low-voltage dry-type distribution transformers shall be modeled only if the proposed building transformers exceed the efficiency requirements of Table 8.1. If modeled, the efficiency requirements from Table 8.1 shall be used. The ratio of the capacity to peak electrical load of the transformer shall be the same as the ratio in the proposed design.

G3.1.2.8 Economizer High-Limit Shutoff. The high-limit shutoff shall be a dry-bulb fixed switch with setpoint temperatures in accordance with the values in Table G3.1.2.6B.

TABLE G3.1.2.6A Climate Conditions under which Economizers are Included for Comfort Cooling for Baseline Systems 3 through 8

Climate Zone	Conditions
1a, 1b, 2a, 3a, 4a	N.R.
Others	Economizer Included

N.R. means that there is no conditioned building floor area for which economizers are included for the type of zone and climate.

TABLE G3.1.2.6B Economizer High-Limit Shutoff

Climate Zone	Conditions
1b, 2b, 3b, 3c, 4b,4c, 5b, 5c, 6b, 7, 8	75°F
2a, 3a, 4a	28 Btu/lb (47 kJ/kg)
5a, 6a, 7a	70°F
Others	65°F

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FOREWORD

Research conducted by the California Energy Commission and others indicates that electronically commutated motors (ECM) are more efficient and cost effective than standard (e.g., PSC) motors in applications where the fan runs many hours per day (e.g., toilet exhaust fans, series fan-powered VAV boxes, and fan-coil units), except for those in the airstream that operate only when heating a space, in which case the motor essentially behaves as an electric resistance heater. ECMs also reduce energy because their speed can be adjusted for balancing rather than throttling dampers. (ECMs can also be used for variable-speed capacity control but that is not a requirement of this section.)

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Addendum aj to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

6.5.3.5 Fractional Horsepower (Kilowatt) Fan Motors. Motors for fans that are 1/12 hp (62.1 W) or greater and less than 1 hp (0.746 kW) shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of a varying motor speed.

Exceptions:

1. Motors in the airstream within fan coils and terminal units that operate only when providing heating to the space served.
2. Motors installed in space conditioning equipment certified under Section 6.4.1.
3. Motors covered by Table 10.8.d or 10.8.e.

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FOREWORD

This addendum modifies the baseline building design used in Appendix G.

Currently in Appendix G, the choice of space heating energy source (either electricity or fossil fuel) in the proposed design determines the energy source in the baseline building design. Similarly, the choice of service water heating energy source in the proposed design determines the water heating energy source in the baseline building design.

This results, for some buildings, in wide variations in baseline energy-cost budgets, depending on whether electricity or fossil fuel is specified for the proposed design. In some cases, the choice of either electricity or fossil fuel in the proposed design provides a much higher baseline energy-cost budget than if the alternative energy source were used. This provides an incentive to use one energy source over the other in order to claim greater savings.

To prevent this opportunity for gaming the energy savings projected using Appendix G, this addendum specifies the energy source for space heating and water heating to be used in the baseline building design, regardless of the type of energy specified for space heating or water heating in the proposed design.

The space heating energy source is determined by climate zone, and the water heating energy source is determined by the type of activity that is proposed for that area of the building. (Building area, rather than whole building, is used for water heating in order to accommodate mixed-use buildings.)

Electric space heating is specified for the baseline building design for climate zones where electric space heating is most common (Climate Zones 1 through 3a) and fossil fuel space heating is specified in the baseline building design where it is more common (Climate Zones 3b through 8.)

Similarly, building areas such as offices, where electricity is most often used for water heating, specify electric water heating for the baseline building design, and uses such as hotels, where fossil fuels are used more often for service water heating, specify fossil fuel water heating for the baseline building design.

Where fossil fuels are specified using this procedure, the baseline building energy costs will be based on natural gas costs, unless natural gas is not available at the building location, in which case propane is used for energy costs

The choices of space heating and service water heating energy sources were based on the most common energy source found for that application in the most recent (2003) DOE EIA CBECS survey and on current standard practice.

The specification of a consistent baseline building energy budget for a particular proposed building, regardless of the energy source chosen for actual installation in the proposed building, should make energy savings determined using Appendix G more consistent and equitable.

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Addendum al to Standard 90.1-2010

Revise the Standard as follows (I-P and SI units).

G2.4 Energy Rates

Exception: On-site renewable energy sources or site-recovered energy shall not be considered to be purchased energy and shall not be included in the proposed building performance. Where on-site renewable or site recovered sources are used, the baseline building performance shall be based on the energy source used as the backup energy source or on the use of ~~electricity~~ <u>the baseline system energy source in that category</u> if no backup energy source has been specified.

[. . .]

G3.4.1 Baseline HVAC System Type and Description. HVAC systems in the baseline building design shall be based on usage, number of floors, conditioned floor area, and climate zone as specified in Table G3.1.1A and shall conform with the system descriptions in Table G3.1.1B. For systems 1, 2, 3, and 4, each thermal block shall be modeled with its own HVAC system. For systems 5, 6, 7, 8, 9, and 10 each floor shall be modeled with a separate HVAC system. Floors with identical thermal blocks can be grouped for modeling purposes.

Exceptions:

[. . .]

c. For laboratory spaces in a building having a total laboratory exhaust rate greater than 5000 cfm, use a single system of type 5 or 7 serving only those spaces. ~~For all-electric buildings, the heating shall be electric resistance.~~

d. For kitchens with a total exhaust hood airflow rate greater than 5,000 cfm, use system type 5, 6, 7 or 8 with a demand ventilation system on 75% of the exhaust air. The system shall reduce exhaust and replacement air system airflow rates by 50% for one half of the kitchen occupied hours in the baseline design. If the proposed design uses demand ventilation the same air flow rate schedule shall be used. The maximum exhaust flow rate allowed for the hood or hood section shall meet the requirements of Section 6.5.7.1.3 for the numbers and types of hoods and appliances provided for the in the proposed design. ~~For all-electric buildings, the heating shall be electric resistance.~~

[. . .]

<u>h. For hospitals, depending on building type, use System 5 or 7 in all climate zones.</u>

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No. Proposed Building Performance	Baseline Building Performance
10. HVAC Systems	
The HVAC system type and all related performance parameters in the proposed design, such as equipment capacities and efficiencies, shall be determined as follows: a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. c. Where no heating system exists or no heating system has been specified, ~~the heating system classification shall be assumed to be electric, and~~ the system characteristics shall be identical to the system modeled in the baseline building design. d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be identical to the system modeled in the baseline building design. **Exception to d:** Spaces using baseline HVAC system types 9 and 10.	The HVAC system(s) in the baseline building design shall be of the type and description specified in Section G3.1.1, shall meet the general HVAC system requirements specified in Section G3.1.2, and shall meet any system-specific requirements in Section G3.1.3 that are applicable to the baseline HVAC system type(s). <u>Fossil fuel systems shall be modeled using natural gas as their fuel source.</u> <u>**Exception:** For fossil fuel systems where natural gas is not available for the proposed building site as determined by the rating authority, the baseline HVAC system(s) shall be modeled using propane as their fuel source.</u>
11. Service Hot-Water Systems	

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance (Continued)

The service hot water system type and all related performance parameters, such as equipment capacities and efficiencies, in the proposed design shall be determined as follows: a. Where a complete service hot water system exists, the proposed design shall reflect the actual system type using actual component capacities and efficiencies. b. Where a service hot water system has been specified, the service hot water model shall be consistent with design documents. c. Where no service hot water system exists or has been specified but the building will have service hot water loads, a service hot water system shall be modeled that matches the system in the baseline building design and serves the same hot water loads. d. For buildings that will have no service hot water loads, no service hot water system shall be modeled. e. Where a combined system has been specified to meet both space heating and service water heating loads, the proposed design shall reflect the actual system type using actual component capacities and efficiencies.	The service hot water system in the baseline building design ~~shall use the same energy source as the corresponding system in the proposed design and~~ shall conform with the following conditions: a. Where a complete service hot water system exists, the baseline building design shall be as specified in Table G3.1.1c ~~reflect the actual system type~~ using actual component capacities ~~and efficiencies~~. b. Where a new service hot water system has been specified, the heating method shall be as specified in Table G3.1.1c. T~~t~~he system shall be sized according to the provisions of Section 7.4.1 and the equipment shall match the minimum efficiency requirements in 7.4.2. ~~Where the energy source is electricity, the heating method shall be electrical resistance.~~ c. Where no service hot water system exists or has been specified but the building will have service hot water loads, a service water system(s) using the heating method as specified in Table G3.1.1c ~~electrical-resistance heat~~ and matching minimum efficiency requirements of 7.4.4 and the heat recovery requirements of Section 7.4.2 shall be assumed and modeled identically in the proposed and baseline building designs. d. For buildings that will have no service hot water loads, no service hot water system shall be modeled. e. Where a combined system has been specified to meet both space heating and service water heating loads, the baseline building system shall use separate systems meeting the minimum efficiency requirements applicable to each system individually. f. For large, 24-hour-per-day facilities that meet the prescriptive criteria for use of condenser heat recovery systems described in Section 6.5.6.2, a system meeting the requirements of that section shall be included in the baseline building design regardless of the exceptions to Section 6.5.6.2. **Exception:** If a condenser heat recovery system meeting the requirements described in Section 6.5.6.2 cannot be modeled, the requirement for including such a system in the actual building shall be met as a prescriptive requirement in accordance with Section 6.5.6.2, and no heat-recovery system shall be included in the proposed or baseline building designs. g. Service hot-water energy consumption shall be calculated explicitly based upon the volume of service hot water required and the entering makeup water and the leaving service hot-water temperatures. Entering water temperatures shall be estimated based upon the location. Leaving temperatures shall be based upon the end-use requirements. h. Where recirculation pumps are used to ensure prompt availability of service hot water at the end use, the energy consumption of such pumps shall be calculated explicitly. i. Service water loads and usage shall be the same for both the baseline building design and the proposed design and shall be documented by the calculation procedures described in Section 7.2.1. **Exceptions:** 1. Service hot-water usage can be demonstrated to be reduced by documented water conservation measures that reduce the physical volume of service water required. Examples include low-flow shower heads. Such reduction shall be demonstrated by calculations. 2. Service hot-water energy consumption can be demonstrated to be reduced by reducing the required temperature of service mixed water, by increasing the temperature, or by increasing the temperature of the entering makeup water. Examples include alternative sanitizing technologies for dishwashing and heat recovery to entering makeup water. Such reduction shall be demonstrated by calculations. 3. Service hot-water usage can be demonstrated to be reduced by reducing the hot fraction of mixed water to achieve required operational temperature. Examples include shower or laundry heat recovery to incoming cold-water supply, reducing the hot-water fraction required to meet required mixed-water temperature. Such reduction shall be demonstrated by calculations. j. Gas storage water heaters shall be modeled using natural gas as their fuel source. **Exception:** Where natural gas is not available for the proposed building site, as determined by the rating authority, gas storage water heaters shall be modeled using propane as their fuel source.

TABLE G3.1.1A Baseline HVAC System Types

Building Type	~~Fossil Fuel, Fossil/Electric Hybrid, and Purchased Heat~~ Climate Zones 3b, 3c, and 4–8	~~Electric and Other~~ Climate Zones 1–3a
Residential	System 1—PTAC	System 2—PTHP
Nonresidential and 3 floors or less and <25,000 ft^2	System 3—PSZ-AC	System 4—PSZ-HP
Nonresidential and 4 or 5 floors and <25,000 ft^2 or 5 floors or less and 25,000 ft^2 to 150,000 ft^2	System 5—Packaged VAV with reheat	System 6—Packaged VAV with PFP boxes
Nonresidential and more than 5 floors or >150,000 ft^2	System 7—VAV with reheat	System 8—VAV with PFP boxes
Heated only storage	System 9—Heating and ventilation	System 10—Heating and ventilation

Notes:

1. Residential building types include dormitory, hotel, motel, and multifamily. Residential space types include guest rooms, living quarters, private living space, and sleeping quarters. Other building and space types are considered nonresidential.
~~Where no heating is to be provided or no heating energy source is specified, use the "Electric and Other" heating source classification.~~
2. Where attributes make a building eligible for more than one baseline system type, use the predominant condition to determine the system type for the entire building except as noted in Exception a to section G3.1.1.
3. For laboratory spaces in a building have a total laboratory exhaust rate greater than 5000 cfm, use a single system of type 5 or 7 serving only those spaces. ~~For all-electric buildings, the heating shall be electric resistance.~~
4. For hospitals, depending on building type, use System 5 or 7 in all climate zones.

TABLE G3.1.1C Baseline Service Hot-Water System

Building Area Type	Baseline Heating Method
Automotive facility	Gas storage water heater
Convention center	Electric resistance storage water heater
Courthouse	Electric resistance storage water heater
Dining: Bar lounge/leisure	Gas storage water heater
Dining: Cafeteria/fast food	Gas storage water heater
Dining: Family	Gas storage water heater
Dormitory	Gas storage water heater
Exercise center	Gas storage water heater
Fire station	Gas storage water heater
Gymnasium	Gas storage water heater
Health-care clinic	Gas storage water heater
Hospital	Gas storage water heater
Hotel	Gas storage water heater
Library	Electric resistance storage water heater
Manufacturing facility	Gas storage water heater
Motel	Gas storage water heater
Motion picture theater	Electric resistance storage water heater
Multifamily	Gas storage water heater
Museum	Electric resistance storage water heater
Office	Electric resistance storage water heater
Parking garage	Electric resistance storage water heater
Penitentiary	Gas storage water heater
Performing arts theater	Gas storage water heater
Police station	Electric resistance storage water heater
Post office	Electric resistance storage water heater
Religious building	Electric resistance storage water heater
Retail	Electric resistance storage water heater
School/university	Gas storage water heater
Sports arena	Gas storage water heater
Town hall	Electric resistance storage water heater
Transportation	Electric resistance storage water heater
Warehouse	Electric resistance storage water heater
Workshop	Gas storage water heater
All Others	Gas storage water heater

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FOREWORD

This addendum adds requirements for boiler turndown with a design input of at least 1,000,000 Btu/h (293 kW).

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum am to Standard 90.1-2010

Revise Section 3 as follows (I-P and SI units)

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

3.1 General. Certain terms, abbreviations, and acronyms are defined in this section for the purposes of this standard. These definitions are applicable to all sections of this standard. Terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used. Ordinarily accepted meanings shall be based upon American standard English language usage as documented in an unabridged dictionary accepted by the adopting authority.

[. . .]

boiler: a self-contained low-pressure appliance for supplying steam or hot water.

modulating boiler: a boiler that is capable of more than a single firing rate in response to a varying temperature or heating load.

packaged boiler: a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections. A packaged boiler includes factory-built boilers manufactured as a unit or system, disassembled for shipment, and reassembled at the site.

boiler system: one or more boilers and their piping and controls that work together to supply steam or hot water to heat output devices remote from the boiler.

Revise Section 6 as follows (I-P and SI units)

6.5.4 Hydronic System Design and Control

6.5.4.1 Boiler Turndown. Boiler systems with design input of at least 1,000, 000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table 6.5.4.6.

The system turndown requirement shall be met through the use of multiple single-input boilers, one or more modulating boilers, or a combination of single-input and modulating boilers.

All boilers shall meet the minimum efficiency requirements in Table 6.8.1.

TABLE 6.5.4.6 Boiler Turndown

Boiler System Design Input, Btu/h (kW)	Minimum Turndown Ratio
≥1,000,000 and ≤5,000,000 (≥293 and ≤1465)	3 to 1
>5,000,000 and ≤10,000,000 (>1465 and ≤2931)	4 to 1
>10,000,000 (2931)	5 to 1

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FOREWORD

The current building envelope trade-off option relies on a complex set of regression equations described in Appendix C and based on analyses of building enclosures for the three broad space-conditioning categories. This proposed addendum modifies the building envelope trade-off option, primarily through a replacement of the Appendix C equations, and now requires the use of building energy analysis software (e.g., EnergyPlus or DOE-2). The intent, as in the current version of Appendix C, is to outline a procedure for a software developer to produce standalone software that performs calculations to compare the proposed envelope performance factor (PEPF) to the base envelope performance factor (BEPF) to show compliance with ASHRAE/IES Standard 90.1 of the building envelope design.

The primary benefits of the proposed changes are as follows:

- *A simplified approach utilizing energy simulations of design*
- *Specific envelope parameters*
- *Small but significant changes that provide additional flexibility for designers*
- *Improved compliance flexibility at a time of increasing stringency*
- *A foundation to allow future modifications where the current Appendix C allows few areas that can be modified or improved*

The basic approach in the proposed modifications uses the energy analysis methodology included in the current energy cost budget (ECB) method. All non-envelope-related provisions (e.g., HVAC and lighting) are held constant in the PEPF and BEPF calculations, are not allowed to be modified by the user, and reflect prescriptive provisions of Standard 90.1. The EPF calculations allow for 33 individual building area types in addition to the three space-conditioning categories currently included. Schedules, setpoints, miscellaneous loads, ventilation, occupancy rates, and occupant heat gains are prescribed based on building area type.

Although this proposed addendum outlines a replacement of Appendix C in its entirety, this is done primarily for clarity. The substance of proposed changes to Appendix C are minor in most areas. However, text changes are fairly extensive, and the incorporation of energy analysis procedures rendered a document with individual underline and strikethrough of substantive changes difficult to read. As such, the following portion of this foreword discusses individual sections of the proposed addendum and how they modify the current building envelope trade-off option. Unless specified here, the proposed addendum reflects the current building envelope trade-off option, primarily outlined in Appendix C.

Section 5.6.1.1: *Requires building envelope input parameters to reflect the design documents (or existing building components) and allows envelope assemblies constituting <5% of each assembly type to be merged with similar assemblies, consistent with the approach currently outlined in ECB.*

Appendix C, General: *Where building envelope assembly descriptions currently require designation of an adjacent space-conditioning category, the proposed addendum also includes building area type. This allows more accurate representation of internal loads by building/area type.*

Appendix C, General: *Where the current Appendix C specifies thermostat setpoints, miscellaneous loads, ventilation, occupancy rates, and occupant heat gains for all buildings, the proposed addendum includes this information and related schedules by building area type.*

Section C1.2: *Additional information is required to separate zones and properly assign boundary conditions in the energy analysis.*

Section C2: *Output requirements include a summary of information that may be helpful to designers in assessing on which areas to focus to achieve compliance, such as heat gains and losses through individual classes of construction.*

Section C3, General: *This section is new but reflects, with some modifications, the simulation program requirements for ECB.*

Section C3.3: *Purchased energy rates specified are equivalent to those used by SSPC 90.1 to assess the cost effectiveness of the standard's prescriptive criteria.*

Section C3.5.2: *The thermal zone creation is similar to the current Standard 90.1 Appendix C approach with some modifications:*

- *Additional zones created due to the addition of the building-area-type parameter.*
- *A fixed zone height of 15 ft (4.6 m).*
- *Vertical fenestration is centered on the associated surface with the same aspect ratio as the associated surface. Vertical fenestration with the same U-factor, SHGC, and VT and that are associated with the same surface can be "lumped."*
- *Each zone is modeled as fully enclosed with zone boundaries not representing building envelope assemblies modeled as adiabatic.*

Section C3.5.3: *Rather than assuming that all lighting in perimeter zones is controlled by continuous daylight dimming, as in the current Appendix C, the proposed addendum defines daylight areas in nonresidential buildings adjacent to vertical fenestration and below skylights; photosensor locations are also specified. Daylight areas are not included for residential buildings as Standard 90.1 does not require daylight controls for residential buildings.*

Section C3.5.5.1: *The proposed addendum includes shades that are modeled to be lowered when transmitted luminous intensity or transmitted solar energy exceed specified thresholds, then remain lowered for the remainder of the day. This approach reflects studies by Lawrence Berkeley National Laboratory (LBNL). Specified shade properties reflect average properties of typical blinds and shades.*

Section C3.5.5.2: *Dynamic glazing is allowed to be modeled.*

Section C3.5.5.3: *Infiltration is specified as 0.4 cfm/ft^2 (2.03 L/s·m^2) at 0.3 in. wc (75 Pa) and with implementation procedures consistent with Appendix G.*

Section C3.5.7: *50% of lighting power density (LPD) in daylight is as modeled with continuous daylight dimming controls. This approach is used because Standard 90.1 does not require daylight dimming controls in all perimeter spaces. Minimum light output and the associated minimum power input are specified and based on typical continuous daylight dimming controls. LPD is specified as the Standard 90.1 prescriptive maximum for the appropriate building area type.*

Section C3.5.8: *A basic HVAC system with constant efficiencies, based on the prescriptive requirements in Standard 90.1, is specified. This system is not intended to simulate the actual system of the proposed building design, but rather a simple system held constant in the PEPF and BEPF calculations. Outdoor air economizers are modeled where generally required in Standard 90.1 (i.e., all climate zones other than Climate Zone 1). Supply air rates are consistent with ECB. System sizing capacities are based on sizing simulation results multiplied by 1.5. This is not intended to reflect a recommended safety factor; it is intended to provide equipment sufficient to meet heating and cooling loads throughout the annual simulation. Oversized equipment will not have a significant effect because constant efficiencies are used in the calculations.Fans cycle on and off when spaces call for heating or cooling.*

Section C3.6: *The BEPF model modifies the building envelope of the PEPF model as follows:*

- *U-factor and SHGC of building envelope assemblies are equal to the prescriptive requirements for the appropriate class of construction, space-conditioning category, and climate zone. This approach is consistent with ECB.*
- *Where Standard 90.1 includes prescriptive criteria for exterior roof surfaces, roof surfaces in the BEPF include properties equal to those prescriptive criteria. This approach is consistent with ECB.*
- *Fenestration area is reduced proportionately across all surfaces until it meets the maximum area allowed under the prescriptive criteria. This approach is consistent with ECB.Daylight areas and photosensor locations are defined after the fenestration area is reduced.*
- *If, after reducing the fenestration area, the BEPF model does not meet the prescriptive orientation criteria, the BEPF is calculated by simulating the building with its actual orientation and again after rotating it 90, 180 and 270 degrees, then averaging the four results. This approach is consistent with Appendix G.*

Permanent shading devices (e.g., fins and overhangs) are not modeled. This approach is consistent with ECB.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum an to Standard 90.1-2010

Add the following definition to Section 3.2 (I-P and SI units).

***building envelope trade-off schedules and loads*:** the schedules and internal loads[1], by building area type, to be used in the building envelope trade-off option simulations described in Appendix C.

Modify Section 5 as follows (I-P and SI units).

5.6 Building Envelope Trade-Off Option

5.6.1 The building envelope complies with the standard if

a. the proposed building satisfies the provisions of Sections 5.1, 5.4, 5.7, and 5.8 and
b. the envelope performance factor of the proposed building is less than or equal to the envelope performance factor of the budget building.

5.6.1.1 ~~The envelope performance factor considers only the building envelope components.~~ All components of the building envelope shown on architectural drawings or installed in existing buildings shall be modeled in the proposed building design. The simulation model fenestration and opaque envelope types and area shall be consistent with the design documents. Any envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described, provided it is similar to an assembly being modeled. If not separately described, the area of an envelope assembly shall be added to the area of an assembly of that same type with the same orientation and thermal properties.

~~**5.6.1.2** Schedules of operation, lighting power, equipment power, occupant density, and mechanical systems shall be the same for both the proposed building and the budget building.~~

5.6.1.2 Trade-Offs Limited to Building Permit. When the building permit being sought applies to less than the whole building, parameters relating to unmodified existing conditions or to future building components shall be identical for both the proposed envelope performance factor and the base envelope performance factor. Future building components shall meet the prescriptive requirements of Sections 5.5.

5.6.1.3 Envelope performance factor shall be calculated using the procedures of Normative Appendix C.

[1] Schedules and internal loads, by building area type, are located at http://sspc901.ashraepcs.org/content.html.

Delete Appendix C in its entirety and replace with the following (I-P and SI units).

NORMATIVE APPENDIX C— METHODOLOGY FOR BUILDING ENVELOPE TRADE-OFF OPTION IN SECTION 5.6

C1. MINIMUM INFORMATION

The following minimum information shall be specified for the proposed design.

C1.1 At the Building Level. The floor area, broken down by space-conditioning categories and building area type, shall be specified. Each building area type shall be chosen from Table 9.5.1.

C1.2 At the Exterior and Semi-Exterior Surface Level. The building envelope assembly type, gross area, orientation, tilt, and associated space-conditioning category and building area type shall be specified. The surface shall be designated as exterior or semi-exterior. A semi-exterior surface separating a conditioned space from a semi-exterior space shall be specified with two associated space-conditioning categories. A semi-exterior surface separating a conditioned space from an unconditioned space shall be specified with an associated space-conditioning category and with an adjacency to an unconditioned space. Exterior surfaces with the same building envelope assembly type and associated space-conditioning category and building area type whose orientations differ by no more than 22.5 degrees and whose tilts differ by no more than 22.5 degrees are allowed to be described as a single surface.

C1.2.1 For Roofs. The class of construction, opaque area, U-factor, HC, and insulation position shall be specified. Where three-year-aged test data for the solar reflectance and three-year-aged thermal emittance of the exterior roof surface are available, the three-year-aged solar reflectance and three-year-aged thermal emittance shall be specified.

C1.2.2 For Above-Grade Walls. The class of construction, opaque area, U-factor, HC, and insulation position shall be specified.

C1.2.3 For Below-Grade Walls. The opaque area, average depth to the bottom of the wall, C-factor, HC, and insulation position shall be specified.

C1.2.4 For Floors. The class of construction, opaque area, U-factor, HC, and insulation position shall be specified.

C1.2.5 For Slab-On-Grade Floors. The class of construction, perimeter length, F-factor, and HC shall be specified.

C1.2.6 For Uninsulated Assemblies. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages, roof parapet) shall be separately modeled.

C1.3 For Opaque Doors. The class of construction, area, and U-factor shall be specified. Each opaque door shall be associated with a surface as defined in Section C1.2 and shall have the orientation of that surface.

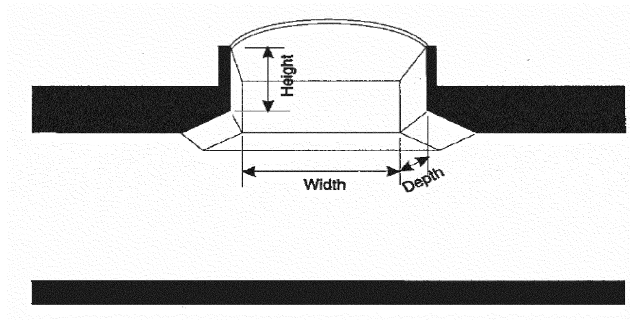

Figure C1.4 Skylight well dimensions.

C1.4 For Fenestration. The class of construction, area, U-factor, SHGC, VT, and PF shall be specified for fenestration. For skylight wells, the width, depth, and height shall be defined as shown in Figure C1.4. Each fenestration element shall be associated with a surface as defined in Section C1.2 and shall have the orientation of that surface.

C2. OUTPUT REQUIREMENTS

Output reports shall contain the following information.

C2.1 Name and contact information of the entity executing the simulation, and date of report.

C2.2 Location of the building, including street address and climate zone.

C2.3 The location corresponding to the weather data used to perform the simulation.

C2.4 The simulation program used to perform the simulation.

C2.5 Tables summarizing the minimum information described in Section C1.

C2.6 All differences between the proposed envelope performance factor and the base envelope performance factor.

C2.7 Total conductive heat gain and conductive heat loss through all opaque classes of construction.

C2.8 Total conductive heat gain, conductive heat loss, and solar heat gain through all fenestration classes of construction.

C3. SIMULATION GENERAL REQUIREMENTS

C3.1 Simulation Program. The simulation program shall be a computer-based program for the analysis of energy consumption in buildings. The simulation program shall include calculation methodologies for the building components being modeled.

Note: Simulation programs include, but are not limited to, EnergyPlus and DOE-2.

C3.1.1 The simulation program shall be approved by the adopting authority and shall, at minimum, have the ability to explicitly model all of the following:

a. The base envelope performance factor, using only the input for the proposed envelope performance factor. The calculation procedure shall not allow the user to directly modify the building component characteristics of the base design.
b. 8760 hours per year.
c. Hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation, defined separately for each day of the week and holidays.
d. Thermal mass effects.
e. The number of thermal zones in the proposed building or nine thermal zones, whichever is greater.
f. Air-side economizers with integrated control.
g. Continuous daylight dimming controls and photosensors.

C3.1.2 The simulation program shall have the ability to determine the proposed envelope performance factor and base envelope performance factor by calculating annual energy costs.

C3.1.3 The simulation program shall be capable of performing design load calculations to determine required HVAC equipment capacities and airflow rates in accordance with Section 6.4.2 for both the proposed envelope design and the budget envelope design.

C3.1.4 The simulation program shall be tested according to ASHRAE Standard 140, and the results shall be published by the software provider.

C3.2 Climatic Data. The simulation program shall perform the simulation using hourly values of climatic data, including temperature, humidity, solar radiation, and wind speed and direction from representative climatic data, for the proposed envelope design location. For cities or urban regions for which several climatic data sources are available and for locations for which weather data are not available, the designer shall select available weather data that represent the climate at the construction site. Selected weather data shall be approved by the authority having jurisdiction.

C3.2.1 Surface Exposure. Semi-exterior surfaces separating conditioned spaces from unconditioned spaces shall be simulated as exterior surfaces with no exposure to wind or solar radiation.

C3.3 Purchased Energy Rates. The following rates for purchased energy shall be used to determine the proposed envelope performance factor and the base envelope performance factor:

a. Electricity: 0.1032/kWh
b. Heating: 0.99/therm

Exception: Where approved by the authority having jurisdiction, actual annual rates for purchased energy or state average energy prices published by the Department of Energy's Energy Information Administration shall be permitted. The same rates shall be used for both the proposed envelope performance factor and the base envelope performance factor.

C3.4 Compliance Calculations. The proposed envelope performance factor and base envelope performance factor shall be calculated using the same

a. simulation program,
b. climatic data, and
c. purchased energy rates.

C3.5 Calculation of Proposed Envelope Performance Factor. The simulation model for calculating the proposed envelope performance factor shall be developed in accordance with Sections C3.5.1 through C3.5.7.

C3.5.1 Space Conditioning. All conditioned spaces in the proposed building design shall be simulated as being both heated and cooled even if no cooling or heating system is being installed. Temperature control setpoints and schedules shall be consistent with those in the building envelope tradeoff schedules and loads for the applicable building area type. All semiheated spaces shall be simulated as being heated and not cooled. The heating temperature control setpoint shall be 50°F (10°C) for all hours.

C3.5.2 Model Geometry and Thermal Zones. The building model shall be divided into thermal zones as described in C3.5.2a through C3.5.2j.

a. Determine the ratio (R_c) of the floor area to the gross wall area for each unique combination of space-conditioning category and building area type. The index "c" refers to a combination of space-conditioning category and building area type as defined for each surface.
b. Create a perimeter zone for each unique combination of building area type, above-grade-wall orientation, and space-conditioning category. If there is more than one above-grade-wall assembly for a building area type and orientation, each above-grade-wall assembly shall be placed end-to-end in the order they are defined. The area of each perimeter zone shall be the gross wall area of the zone times R_c or 1.25, whichever is smaller.
c. For each unique combination of space-conditioning category and building area type with R_c greater than 1.25, interior zones shall be created and used in the trade-off procedure. The area of the interior zone shall be the total area for the unique combination of space-conditioning category and building area type less the area of the perimeter zones for that combination of space-conditioning category and building area type.
d. Create a below-grade zone for each unique combination of space-conditioning category and building area type associated with below-grade walls. If there is more than one below-grade-wall assembly for a building area type, each below-grade-wall assembly shall be placed end-to-end in the order they are defined. The area of each below-grade zone shall be the gross wall area of the zone times R_c or 1.25, whichever is smaller.
e. The wall height and the height of each thermal zone shall be 15 ft (4.6 m).
f. Roof area and floor area associated with each building area type shall be prorated among all zones of the corresponding building area type in proportion to the zone

area of each zone. Roof area and floor area in each zone shall be centered in the horizontal plane of the zone with the same aspect ratio as the horizontal plane of the zone.

g. Slab-on-grade floor perimeter associated with each building area type shall be prorated among perimeter zones of the corresponding building area type in proportion to the area of each zone.
h. Vertical fenestration area shall be assigned to the associated surface as described in Section C1.4. Vertical fenestration shall be centered on the associated surface with the same aspect ratio as the associated surface. Windows with equivalent U-factor, SHGC, and VT that do not include fins may be combined into a single window on the associated surface.
i. Skylight area shall be assigned to the associated surface as described in Section C1.4, prorated among interior zones containing the roof area with which the skylight area is associated, in proportion to the associated roof area. If the total skylight area exceeds the associated roof area in interior zones, the remaining skylight area shall be prorated among perimeter zones containing the roof area with which the skylight area is associated, in proportion to the associated roof area.
j. Each zone shall be modeled as being fully enclosed. Zone boundaries not created as described above shall be modeled as adiabatic interior surfaces.

C3.5.3 Daylight Area and Photosensor Location. Daylight areas and photosensors shall not be modeled in residential zones. In each nonresidential zone, daylight areas and photosensor locations shall be modeled in accordance with Sections C3.5.3a through C3.5.3d.

a. For each nonresidential zone associated with vertical fenestration, the daylight area shall be modeled as directly adjacent to the vertical fenestration with a width equal to the width of the vertical fenestration and a depth equal to the head height of the vertical fenestration.
b. In each nonresidential zone associated with skylights, the daylight area under skylights shall be modeled as bounded, in each direction, by the edge of the skylight area plus 10 ft. or the distance to the edge of the zone, whichever is less.
c. For each daylight area associated with vertical fenestration, a photosensor shall be modeled as located at the center of the width of the daylight area, at the depth of the daylight area and at a height of 3 ft.
d. For each daylight area associated with a skylight, a photosensor shall be modeled as located at the center of the horizontal plane of the skylight and at a height of 5 ft.

C3.5.4 Sechedules. The schedule types listed in Section C3.1.1c shall be required input. The schedules shall be consistent with those in the building envelope trade-off schedules and loads for the applicable building area type.

C3.5.5 Building Envelope. The building envelope shall reflect the information specified in Section C1.

Exception: Where three-year-aged test data for the solar reflectance and three-year-aged thermal emittance of the exterior roof surface are unavailable, the exterior roof surface shall be modeled with a solar reflectance of 0.30 and a thermal emittance of 0.90.

C3.5.5.1 Shading. Manually operated interior shades shall be modeled on all vertical fenestration. Shades shall be modeled to be lowered when the transmitted luminous intensity is greater than 2000 cd/m^2 or the direct solar transmitted energy exceeds 30 Btu/h·ft^2 (95 W/m^2) and then remain lowered for rest of the day. Shades shall be modeled with visible light transmittance of 0.10, visible light reflectance of 0.40, solar transmittance of 0.21, and solar reflectance of 0.23. Permanent shading devices such as fins and overhangs shall be modeled.

C3.5.5.2 Dynamic Glazing. Automatically controlled dynamic glazing is allowed to be modeled. Manually controlled dynamic glazing shall use the average of the minimum and maximum values for both SHGC and VT.

C3.5.5.3 Infiltration. The peak infiltration rate of the building envelope (I_{75Pa}) at a fixed building pressure differential of 0.3 in. wc (75 Pa) shall be 0.4 cfm/ft^2 (2.03 L/s·m^2) exterior building enclosure area. The peak infiltration rate of the building envelope shall be converted to the appropriate units to describe the peak infiltration as a function of exterior wall area as follows:

$$I_{EW} = 0.112 \times I_{75Pa} \times S/A_{EW}$$

where

I_{75Pa} = air leakage rate of the building envelope expressed in cfm/ft^2 (L/s·m^2) at a fixed building pressure differential of 0.3 in. wc, or 1.57 psf (75 Pa).

S = the total area of the envelope air pressure boundary, including the lowest floor, any below-grade walls, above-grade walls, and roof (or ceiling) (including windows and skylights), separating the interior conditioned space from the unconditioned environment measured in square feet (square meters),

I_{EW} = adjusted air leakage rate of the building envelope at a reference wind speed of 10 mph (4.47m/s) and the above-ground exterior wall area.

A_{EW} = the total above-grade exterior wall area (ft^2)

Exception: If the simulation program cannot simulate infiltration as a function of exterior wall area, the peak infiltration of the building envelope shall be converted to the appropriate units to describe the peak infiltration as a function of floor area as follows:

$$I_{FLR} = 0.112 \times I_{75Pa} \times S/A_{FLR}$$

where

I_{FLR} = adjusted air leakage rate of the building envelope at a reference wind speed of 10 mph (4.47m/s) and the above-ground exterior wall area.

A_{FLR} = the total gross floor area, ft^2 (m^2)

C3.5.5.3.1 Infiltration Schedule. Infiltration shall be adjusted in accordance with the infiltration schedule in the building envelope trade-off schedules and loads for the applicable building area type.

C3.5.6 Interior Surfaces. Interior surfaces shall be modeled with visible light reflectances of 0.80 for ceilings, 0.50 for walls, and 0.20 for floors. Interior surfaces shall be modeled with a thermal emittance of 0.90.

C3.5.7 Lighting. Lighting power shall be determined using the lighting power density in Table 9.5.1 for the applicable building area type. Lighting power shall be adjusted in accordance with the lighting schedule in the building envelope trade-off schedules and loads for the applicable building area type. Fifty percent (50%) of lighting in daylight areas shall be modeled with continuous daylight dimming controls such that when sufficient daylight is available at the corresponding photosensor, lighting power is reduced to maintain a minimum 50 fc for conditioned spaces and 30 fc for semiheated spaces. The minimum light output for the continuous daylight dimming shall be 6% of peak light output. Power input shall be modeled as 20% of lighting power density at the minimum light output and scaled linearly to 100% of lighting power density at peak light output.

C3.5.8 HVAC Systems. One HVAC system shall be provided for each thermal zone and shall have the following characteristics:

a. *Fan control:* Constant volume
b. *Cooling:* Electrically-provided cooling with constant COP equal to the minimum IEER allowed for air-cooled air conditioners of "All Other" heating section type with ≥65,000 Btu/h and <135,000 Btu/h capacity, in accordance with Table 6.8.1A, divided by 3.412.
c. *Heating:* Gas furnace with constant thermal efficiency equal to the minimum AFUE allowed for gas-fired warm-air furnaces with maximum capacity <225,000 Btu/h, in accordance with Table 6.8.1E.
d. *Ventilation:* The ventilation rate for each building area type shall be consistent with the ventilation rate in the building envelope trade-off schedules and loads for the applicable building area type.
e. *Economizers:* Outdoor air economizers, except in Climate Zone 1. The high-limit shutoff shall be "Fixed Dry Bulb" type as described in Table 6.5.1.1.3B.
f. *Supply Air Rates:* System design supply air rates shall be based on a supply-air-to-room-air temperature difference of 20°F.
g. *Sizing:* System capacities used in the annual simulation shall be 1.5 times the capacities determined by the sizing simulations.
h. Fans shall cycle on whenever the space calls for heating or cooling. The fan energy shall be included in the energy efficiency rating of the equipment, and the fan energy shall not be modeled explicitly.

C3.5.9 Miscellaneous Loads. Miscellaneous loads shall be modeled as included in the (2.03 L/s·m^2) for the applicable building area type.

C3.5.10 Occupant Density. The occupant density shall be modeled according to the peak occupant density and the occupancy rate schedule in the building envelope trade-off schedules and loads for the applicable building area type.

C3.5.11 Heat Gain from Occupants. The sensible and latent heat gain due to occupants shall be modeled as included in the building envelope trade-off schedules and loads for the applicable building area type.

C3.6 Calculation of Base Envelope Performance Factor. The simulation model for calculating the base envelope performance factor shall modify the simulation model for calculating the proposed envelope performance factor as follows:

a. All opaque assemblies shall be modeled with the maximum U-factor required in Section 5.5.3 for the appropriate class of construction, space-conditioning category, and climate zone. Mass walls and mass floors shall be modeled with HC equal to 7.2 Btu/ft^2-°F. All other opaque assemblies shall be modeled with the same HC as the proposed building design. Mass walls shall be modeled with equal mass on each side of the insulation. All other opaque assemblies shall be modeled with insulation on the exterior.

b. The exterior roof surfaces shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.1.1a. All other roofs, including roofs exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as in the proposed design.

c. Fenestration shall be assumed to be flush with the exterior wall or roof. If the fenestration area for new buildings or additions exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. If the fenestration area facing west or east of the proposed building exceeds the area limit set in Section 5.5.4.5, the baseline building performance shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results of the four simulations. Fenestration U-factor and SHGC shall be the maximum allowed for the appropriate class of construction, space-conditioning category, and climate zone in accordance with Section 5.5.4. Where there is no SHGC requirement, the SHGC shall be equal to 0.40 for all vertical fenestration, and 0.55 for skylights. The VT for fenestration in the base envelope design shall be equal to 1.10 times the SHGC.

d. Manually operated interior shades shall be modeled on all vertical fenestration as described in Section C3.5.5.1. Permanent shading devices, such as fins and overhangs, shall not be modeled.

e. Daylight areas and photosensor locations shall be modeled as described in Section C3.5.3 after reducing the fenestration area as described in Section C3.6c.

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

FOREWORD

In Standard 90.1-2010, the SSPC included data centers within the scope of the standard. A significant factor was to require data centers to have economizers (air or water side). This has been a significant point of contention with TC9.9 and other data design professionals, manufacturers, and building owners.

Some of their points against economizers are static discharge due to low humidity (which currently ASHRAE is funding a research project to evaluate), gaseous contaminants, and reliability (especially in subfreezing climate zones).

TC9.9 has requested from the beginning to include an alternative path (power usage effectiveness [PUE]) to allow the use of developing technologies for the data center industries for which there are no energy modeling tools available. This is a significant issue to design professionals in that without a simulation program available to model these systems, they have to receive approval from the authority having jurisdiction (AHJ) for an exceptional calculation method, which in most cases is beyond the AHJ's knowledge level.

The PUE values were developed using water-cooled chillers with water-side economizers and air-cooled chillers with air-side economizers (no humidification), using prescriptive requirements currently in the standard. The PUE values for all climate zones are able to be achieved by both of these conventional system types.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ap to Standard 90.1-2010

Add the following definitions to Section 3.2 for I-P and SI units.

computer room energy: annual energy use of the data center including all *IT equipment energy* plus energy that supports the IT equipment and computer room space calculated in accordance with industry-accepted standards defined as Total Annual Energy (See Informative Appendix E).

IT equipment energy: annual energy used for computer, storage and network equipment along with supplemental equipment represented by the uninterruptible power supply (UPS) output calculated in accordance with industry-accepted standards (See Informative Appendix E.)

power usage effectiveness (PUE): *computer room energy* divided by *IT equipment energy* calculated in accordance with industry-accepted standards (See Informative Appendix E)

power usage effectiveness—category 0 (PUE_0): peak electric demand (kW) for the entire computer room including IT equipment and supporting infrastructure) divided by (peak electric demand (kW) of the IT equipment.

power usage effectiveness—category 1 (PUE_1): annual energy consumption (kWh) for the entire computer room including IT equipment and supporting infrastructure) divided by (annual energy consumption (kWh) of the IT equipment.

Modify Section 6 as follows for I-P and SI units.

6.2 Compliance Path(s)

6.2.1 Compliance with Section 6 shall be achieved by meeting all requirements for Section 6.1, General; Section 6.7, Submittals; Section 6.8, Minimum Equipment Efficiency; and ~~either~~ one of the following:

a. Section 6.3, Simplified Approach Option for HVAC Systems; or
b. Section 6.4, Mandatory Provision; and Section 6.5, Prescriptive Path; or
c. Section 6.4, Mandatory Provision; and Section 6.6, Alternative Compliance Path for systems identified in this section.

...

6.6 Alternative Compliance Path ~~(Not Used)~~

6.6.1 Computer Rooms Systems. HVAC systems serving the heating, cooling, or ventilating needs of a computer room shall comply with Sections 6.1, 6.4, 6.6.1.1 or 6.6.1.2, 6.6.1.3, 6.7, and 6.8.

6.6.1.1 The computer room PUE_1 shall be less than or equal to the values listed in Table 6.6.1. Hourly simulation of the proposed design, for purposes of calculating PUE_1, shall be based on the ASHRAE Standard 90.1 Appendix G simulation methodology.

Exception: This compliance path is not allowed for a proposed computer room design utilizing a combined heat and power system.

6.6.1.2 The computer room PUE_0 is less than or equal to the values listed in Table 6.6.1; shall be the highest value determined at outdoor cooling design temperatures; and shall be limited to systems only utilizing electricity for an energy source. PUE_0 shall be calculated for two conditions: 100% design *IT equipment energy* and 50% design *IT equipment energy.*

6.6.1.3 Documentation shall be provided, including a breakdown of energy consumption or demand by at least the following components: IT equipment, power distribution losses external to the IT equipment, HVAC systems, and lighting.

TABLE 6.6.1 Power Usage Effectiveness (PUE) Maximum

Climate Zone	PUE[a]
1A	1.61
2A	1.49
3A	1.41
4A	1.36
5A	1.36
6A	1.34
1B	1.53
2B	1.45
3B	1.42
4B	1.38
5B	1.33
6B	1.33
3C	1.39
4C	1.38
5C	1.36
7	1.32
8	1.30

a. PUE_0 and PUE_1 shall not include energy for battery charging.

Add the following to Informative Appendix E for I-P and SI units.

The Green Grid Administration
3855 SW 153rd Drive
Beaverton, Oregon 97006 USA
(T) 503-619-0653
(F) 503-644-6708

Subsection No.	Reference	Title/Source
...		
3.2 computer room energy	Recommendations for Measuring and Reporting Overall Data Center Efficiency v2 17 May 2011	*The Green Grid*
3.2 IT equipment energy	Recommendations for Measuring and Reporting Overall Data Center Efficiency v2 17 May 2011	*The Green Grid*
3.2 power usage effectiveness	Recommendations for Measuring and Reporting Overall Data Center Efficiency v2 17 May 2011	*The Green Grid*
...		

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

FOREWORD

This addendum makes changes to the requirements for fan control for both constant-volume and VAV units, including extending the fan part-load power requirements down to 1/4 hp (0.20 kW). In addition, it defines the requirements for integrated economizer control and defines DX unit capacity staging requirements.

A full economic analysis has been performed using the 2013 economic scalar justification requirements, and payback periods of 0.6 to 4.2 years have been estimated. With a design life of 15 years, these are well below the scalar limit of 9.086 years.

This addendum also makes changes to Table 11.3.2A for coordination and modifies Sections 6.4.3.10, 6.5.1.3, and 6.5.3.2.1. For clarification we have include most of the text from these sections so it is easier to understand the changes being made. We have also shown the changes proposed by addendum t, which is not yet published.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum aq to Standard 90.1-2010

Revise Section 6 as follows (I-P and SI units).

6.3 Simplified Approach Option for HVAC Systems

6.3.1 Scope. The simplified approach is an optional path for compliance when the following conditions are met:

a. building is two stories or fewer in height
b. gross floor area is less than 25,000 ft^2 (2,300 m^2)
c. each HVAC system in the building complies with the requirements listed in Section 6.3.2

6.3.2 Criteria. The HVAC system must meet ALL of the following criteria:

a. The system serves a single HVAC zone.
b. The equipment must meet the variable flow requirements of Section ~~6.4.3.10~~6.5.3.2.1.
c. Cooling (if any) shall be provided by a unitary packaged or split-system air conditioner that is either air-cooled or evaporatively cooled with efficiency meeting the requirements shown in Table 6.8.1A (air conditioners), Table 6.8.1B (heat pumps), or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps) for the applicable equipment category.
d. The system shall have an air economizer meeting the requirements of Section 6.5.1.
e. Heating (if any) shall be provided by a unitary packaged or split-system heat pump that meets the applicable efficiency requirements shown in Table 6.8.1B (heat pumps) or Table 6.8.1D (packaged terminal and room air conditioners and heat pumps), a fuel-fired furnace that meets the applicable efficiency requirements shown in Table 6.8.1E (furnaces, duct furnaces, and unit heaters), an electric resistance heater, or a baseboard system connected to a boiler that meets the applicable efficiency requirements shown in Table 6.8.1F (boilers).
f. The system shall meet the exhaust air energy recovery requirements of Section 6.5.6.1.
g. The system shall be controlled by a manual changeover or dual setpoint thermostat.
h. If a heat pump equipped with auxiliary internal electric resistance heaters is installed, controls shall be provided that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles. The heat pump must be controlled by either (1) a digital or electronic thermostat designed for heat pump use that energizes auxiliary heat only when the heat pump has insufficient capacity to maintain setpoint or to warm up the space at a sufficient rate or (2) a multistage space thermostat and an outdoor air thermostat wired to energize auxiliary heat only on the last stage of the space thermostat and when outside air temperature is less than 40°F. Heat pumps whose minimum efficiency is regulated by NAECA and whose HSPF rating both meets the requirements shown in Table 6.8.1B and includes all usage of internal electric resistance heating are exempted from the control requirements of this part (Section 6.3.2[h]).
i. The system controls shall not permit reheat or any other form of simultaneous heating and cooling for humidity control.
j. Systems serving spaces other than hotel/motel guest rooms, and other than those requiring continuous operation, which have both a cooling or heating capacity greater than 15,000 Btu/h and a supply fan motor power greater than 0.75 hp, shall be provided with a time clock that (1) can start and stop the system under different schedules for seven different day-types per week, (2) is capable of retaining programming and time setting during a loss of power for a period of at least ten hours, (3) includes an accessible manual override that allows temporary operation of the system for up to two hours, (4) is capable of temperature setback down to 55°F during off hours, and (5) is capable of temperature setup to 90°F during off hours.
k. Except for piping within manufacturers' units, HVAC piping shall be insulated in accordance with Tables 6.8.3A and 6.8.3B. Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas, or plastic cover. Cellular foam insulation shall be protected as above or

painted with a coating that is water retardant and provides shielding from solar radiation.

l. Ductwork and plenums shall be insulated in accordance with Tables 6.8.2A and 6.8.2B and shall be sealed in accordance with Section 6.4.4.2.1.
m. Construction documents shall require a ducted system to be air balanced in accordance with industry-accepted procedures.
n. Outdoor air intake and exhaust systems shall meet the requirements of Section 6.4.3.4.
o. Where separate heating and cooling equipment serves the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.
p. Systems with a design supply air capacity greater than 10,000 cfm shall have optimum start controls.
q. The system shall comply with the demand control ventilation requirements in section 6.4.3.9.

[. . .]

~~**6.4.3.10 Single Zone Variable-Air-Volume Controls.** HVAC systems shall have variable airflow controls as follows:~~

~~a. Air-handling and fan-coil units with chilled-water cooling coils and supply fans with motors greater than or equal to 5 hp shall have their supply fans controlled by two-speed motors or variable-speed drives. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:~~

~~1. One half of the full fan speed, or~~
~~2. The volume of outdoor air required to meet the ventilation requirements of Standard 62.1.~~

~~b. Effective January 1, 2012, all air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity at AHRI conditions greater than or equal to 110,000 Btu/h that serve single zones shall have their supply fans controlled by two-speed motors or variable-speed drives. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:~~

~~1. Two-thirds of the full fan speed, or~~
~~2. The volume of outdoor air required to meet the ventilation requirements of Standard 62.1.~~

6.5 Prescriptive Path

6.5.1 Economizers. Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Sections 6.5.1.1 through 6.5.1.4.

Exceptions: Economizers are not required for the systems listed below.

a. Individual fan-cooling units with a supply capacity less than the minimum listed in Table 6.5.1A for comfort cooling applications and Table 6.5.1B for computer room applications.
b. Systems that include non-particulate air treatment as required by Section 6.2.1 in Standard 62.1.
c. In hospitals and ambulatory surgery centers, where more than 75% of the air designed to be supplied by the system is to spaces that are required to be humidified above 35°F dew-point temperature to comply with applicable codes or accreditation standards. In all other buildings, where more than 25% of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F dew-point temperature to satisfy process needs. This exception does not apply to computer rooms.
d. Systems that include a condenser heat recovery system with a minimum capacity as defined in 6.5.6.2.2a or 6.5.6.2.2b.
e. Systems that serve residential spaces where the system capacity is less than five times the requirement listed in Table 6.5.1A.
f. Systems that serve spaces whose sensible cooling load at design conditions, excluding transmission and infiltration loads, is less than or equal to transmission and infiltration losses at an outdoor temperature of 60°F.
g. Systems expected to operate less than 20 hours per week.
h. Where the use of outdoor air for cooling will affect supermarket open refrigerated casework systems.
i. For comfort cooling where the cooling efficiency meets or exceeds the efficiency improvement requirements in Table 6.3.2.
j. Systems primarily serving computer rooms where:
   1. the total design cooling load of all computer rooms in the building is less than 3,000,000 Btu/h and the building in which they are located is not served by a centralized chilled water plant, or
   2. the room total design cooling load is less than 600,000 Btu/h and the building in which they are located is served by a centralized chilled water plant, or
   3. the local water authority does not allow cooling towers, or
   4. less than 600,000 Btu/h of computer room cooling equipment capacity is being added to an existing building
k. Dedicated systems for computer rooms where a minimum of 75% of the design load serves:
   1. those spaces classified as an essential facility
   2. those spaces having a mechanical cooling design of Tier IV as defined by ANSI/TIA-942
   3. those spaces classified under NFPA 70 Article 708 – Critical Operations Power Systems (COPS)
   4. those spaces where core clearing and settlement services are performed such that their failure to settle pending financial transactions could present systemic risk as described in “The Interagency Paper on Sound Practices to Strengthen the Resilience of the US Financial System, April 7, 2003”

TABLE 6.5.1.3 DX Cooling Stage Requirements for Modulating Airflow Units

Rating Capacity, Btu/h (kW)	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement[a]
≥65,000 and <240,000 (18 and 70)	3	≤35% of full load
≥240,000 (70)	4	≤25% full load

a. For mechanical cooling stage control that does not use variable compressor displacement the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

6.5.1.1 Air Economizers

6.5.1.1.1 Design Capacity. Air economizer systems shall be capable of modulating outdoor air and return air dampers to provide up to 100% of the design supply air quantity as outdoor air for cooling.

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

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

6.5.1.1.3 High-Limit Shutoff. All air economizers shall be capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table 6.5.1.1.3A. High-limit shutoff control settings for these control types shall be those listed in Table 6.5.1.1.3B.

6.5.1.1.4 Dampers. Return, exhaust/relief, and outdoor air dampers shall meet the requirements of Section ~~6.4.3~~ 6.4.3.4.3

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

6.5.1.2 Water Economizers

6.5.1.2.1 Design Capacity. Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100% of the expected system cooling load at outdoor air temperatures of 50°F dry bulb/45°F wet bulb and below.

Exceptions:

a. systems primarily serving computer rooms in which 100% of the expected system cooling load at 40°F dry bulb/35°F wet bulb is met with evaporative water economizers.
b. Systems primarily serving computer rooms with dry cooler water economizers which satisfy 100% of the expected system cooling load at 35°F dry bulb.
c. Systems where dehumidification requirements cannot be met using outdoor air temperatures of 50°F dry bulb/45°F wet bulb and where 100% of the expected system cooling load at 45°F dry bulb/40°F wet bulb is met with evaporative water economizers.

6.5.1.2.2 Maximum Pressure Drop. Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a water-side pressure drop of less than 15 ft of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (non-economizer) mode.

6.5.1.3 Integrated Economizer Control. Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not false load the mechanical cooling systems by limiting or disabling the economizer or by any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

Units that include an air economizer shall comply with the following:

a. Unit controls shall have the mechanical cooling capacity control interlocked with the air economizer controls such that the outdoor air damper is at the 100% open position when mechanical cooling is on, and the outdoor air damper does not begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 45°F (7°C).
b. DX units that control the capacity of the mechanical cooling directly based on occupied space temperature shall have a minimum of two stages of mechanical cooling capacity per the following effective dates:

≥75,000 Btu/h (22kW) Rated Capacity—Effective 1/1/2014

≥65,000 Btu/h (18kW) Rated Capacity—Effective 1/1/2016

c. Effective 1/1/2014, all other DX units, including those that control space temperature by modulating the airflow to the space, shall comply with the requirements of Table 6.5.1.3.

6.5.1.4 Economizer Heating System Impact. HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

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

[. . .]

6.5.3.1 Fan System Power Limitation

6.5.3.1.1 Each HVAC system at fan system design conditions shall not exceed the allowable fan system motor nameplate hp (Option 1) or fan system bhp (Option 2) as shown in Table 6.5.3.1.1A. This includes supply fans, return/relief fans, exhaust fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single zone variable-air-volume systems shall comply with the constant volume fan power limitation.

Exceptions:

a. Hospital, vivarium, and laboratory systems that utilize flow control devices on exhaust and/or return to maintain space pressure relationships necessary for occupant health and safety or environmental control may use variable-volume fan power limitation.
b. Individual exhaust fans with motor nameplate horsepower of 1 hp or less.

6.5.3.1.2 Motor Nameplate Horsepower. For each fan, the selected fan motor shall be no larger than the first available motor size greater than the bhp. The fan bhp must be indicated on the design documents to allow for compliance verification by the code official.

Exceptions:

a. For fans less than 6 bhp, where the first available motor larger than the bhp has a nameplate rating within 50% of the bhp, the next larger nameplate motor size may be selected.
b. For fans 6 bhp and larger, where the first available motor larger than the bhp has a nameplate rating within 30% of the bhp, the next larger nameplate motor size may be selected.

6.5.3.2 ~~VAV~~ Fan Control (~~Including Systems Using Series Fan Power Boxes~~)

~~**6.5.3.2.1 Part-Load Fan Power Limitation**. Individual VAV fans with motors 10 hp and larger shall meet one of the following:~~

~~a. The fan shall be driven by a mechanical or electrical variable-speed drive.~~
~~b. The fan shall be a vane-axial fan with variable-pitch blades.~~
~~c. The fan shall have other controls and devices that will result in fan motor demand of no more than 30% of design wattage at 50% of design air volume when static pressure setpoint equals one-third of the total design static pressure, based on manufacturers' certified fan data.~~

6.5.3.2.1 Fan Airflow Control Each cooling system listed in Table 6.5.3.2.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

a. DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control. Low or minimum speed shall not exceed 66% of full speed. At low or minimum speed, the fan system shall draw no more than 40% of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
b. All other units, including DX cooling units and chilled-water units that control the space temperature by modulating the airflow to the space, shall have modulating fan control. Minimum speed shall not exceed 50% of full speed. At minimum speed, the fan system shall draw no more than 30% of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
c. Units that include an air-side economizer to meet the requirements of Section 6.5.1 shall have a minimum of two speeds of fan control during economizer operation.

Exceptions:

a. Modulating fan control is not required for chilled-water and evaporative cooling units with <1 hp (0.75 kW) fan motors if the units are not used to provide ventilation air and the indoor fan cycles with the load.
b. If the volume of outdoor air required to meet the ventilation requirements of Standard 62.1 at low speed exceeds the air that would be delivered at the speed defined in Section 6.5.3.2.1a or 6.5.3.2.1b then the minimum speed shall be selected to provide the required ventilation air.

TABLE 6.5.3.2.1 Effective Dates for Fan Control

Cooling System Type	Fan Motor Size, hp (kW)	Mechanical Cooling Capacity, Btu/h (kW)	Effective Date
DX Cooling	Any	≥110,000 (32)	1/1/2012
		≥75,000 (22)	1/1/2014
		≥65,000 (19)	1/1/2016
Chilled-Water and Evaporative Cooling	≥5 (0.75)	Any	1/1/2010
	≥1/4 (0.2)	Any	1/1/2014

6.5.3.2.2 VAV Static Pressure Sensor Location. Static pressure sensors used to control VAV fans shall be placed in a position such that the controller setpoint is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section 6.5.3.2.3. If this results in the sensor being located downstream of major duct splits, multiple sensors shall be installed in each major branch to ensure that static pressure can be maintained in each.

6.5.3.2.3 VAV Setpoint Reset. For systems with DDC of individual zone boxes reporting to the central control panel, static pressure setpoint shall be reset based on the zone requiring the most pressure; i.e., the setpoint is reset lower until one zone damper is nearly wide open.

6.5.3.3 Multiple-Zone VAV System Ventilation Optimization Control. Multiple-zone VAV systems with DDC of individual zone boxes reporting to a central control panel shall include means to automatically reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency as defined by ASHRAE Standard 62.1, Appendix A.

Exceptions:

a. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
b. Systems required to have the exhaust air energy recovery complying with Section 6.5.6.1.
c. Systems where total design exhaust airflow is more than 70% of total design outdoor air intake flow requirements.

6.5.3.4 Supply-Air Temperature Reset Controls. Multiple zone HVAC systems must include controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperature. The controls shall reset the supply air temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature. Controls that adjust the reset based on zone humidity are allowed. Zones which are expected to experience relatively constant loads, such as electronic equipment rooms, shall be designed for the fully reset supply temperature.

Exceptions:

a. Climate zones 1a, 2a, and 3a
b. Systems that prevent re-heating, re-cooling, or mixing of heated and cooled supply air.
c. Systems in which at least 75 percent of the energy for reheating (on an annual basis) is from site recovered or site solar energy sources.

[. . .]

6.5.9 Hot Gas Bypass Limitation. Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table 6.5.9 and as limited by Section 6.5.1.3

~~**Exception:** Unitary packaged systems with cooling capacities not greater than 90,000 Btu/h~~.

Revise Table 11.3.2A footnote (d) as follows (I-P and SI units).

d. **VAV:** Constant volume can be modeled if the system qualifies for Exception (b) to Section 6.5.2.1. Otherwise, ~~When the proposed building design system has a~~ the supply, return, or relief fan motor ~~25 hp or larger, the corresponding fan in the VAV system of the budget building design~~ shall be modeled assuming a variable speed drive and shall meet the VAV fan part-load performance requirements of Section G.3.1.3.15. ~~For smaller fans, a forward-curved centrifugal fan with inlet vanes shall be modeled.~~ If the proposed building design's system has a DDC system at the zone level, static pressure setpoint reset based on zone requirements in accordance with Section 6.5.3.2.3 shall be modeled.

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

FOREWORD

This addendum adds requirements for walk-in Coolers and Freezers.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ar to Standard 90.1-2010

Modify Section 3 as follows (I-P and SI units).

3.2 Definitions

condensing unit: a factory-made assembly of refrigeration components designed to compress and liquefy a specific refrigerant. It consists of one or more refrigerant compressors, refrigerant condensers (air-cooled, evaporatively cooled, and/or water-cooled), condenser fans and motors (where used), and factory-supplied accessories.

low-temperature refrigeration system: systems for maintaining food products in a frozen state in refrigeration applications.

medium-temperature refrigeration systems: systems for maintaining food products above freezing in refrigeration applications.

saturated condensing temperature: the saturation temperature corresponding to the measured refrigerant pressure at the condenser inlet for single component and azeotropic refrigerants, and the arithmetic average of the dew-point and bubble-point temperatures corresponding to the refrigerant pressure at the condenser entrance for zeotropic refrigerants.

walk-in cooler: an enclosed storage space of <3000 ft^2 (<280 m^2) that can be walked into and that is designed to maintain a space temperature of >32°F (>0°C) but <55°F (<13°C).

walk-in freezer: an enclosed storage space of <3000 ft^2 (<280 m^2) that can be walked into that is designed to maintain a space temperature of ≤ to 32°F (0°C).

3.3 Abbreviations and Acronyms

HVACR	heating, ventilating, air conditioning, and refrigeration

Modify Section 6 as follows (I-P and SI units).

6. HEATING, VENTILATING, ~~AND~~ AIR CONDITIONING, AND REFRIGERATION

[. . .]

6.1.1.1 New Buildings. Mechanical equipment and systems serving the heating, cooling, ~~or~~ ventilating, or refrigeration needs of new buildings shall comply with the requirements of this section as described in Section 6.2.

6.1.1.2 Additions to Existing Buildings. Mechanical equipment and systems serving the heating, cooling, ~~or~~ ventilating, or refrigeration needs of additions to existing buildings shall comply with the requirements of this section as described in Section 6.2.

Exception: When HVACR to an addition is provided by existing HVACR systems and equipment, such existing systems and equipment shall not be required to comply with this standard. However, any new systems or equipment installed must comply with specific requirements applicable to those systems and equipment.

6.1.1.3 Alterations to Heating, Ventilating, ~~and~~ Air Conditioning, and Refrigeration in Existing Buildings

6.1.1.3.1 New HVACR equipment as a direct replacement of existing HVACR equipment shall comply with the specific minimum efficiency requirements applicable to that equipment.

[. . .]

6.2.1 Compliance with Section 6 shall be achieved by meeting all requirements for Section 6.1, General; Section 6.7, Submittals; Section 6.8, Minimum Equipment Efficiency; and either:

a. Section 6.3, Simplified Approach Option for HVACR Systems;

or

b. Section 6.4, Mandatory Provisions; and Section 6.5, Prescriptive Path.

[. . .]

6.4.5 Walk-In Coolers and Freezers. Site-assembled or site-constructed walk-in coolers and freezers shall conform to the following requirements:

a. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 in. (25 mm) of full closure.

Exception to 6.4.5a: Doors wider than 3 ft 9 in. (1.1 m) or taller than 7 ft (2.1 m).

b. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

c. Walk-in coolers shall contain wall, ceiling, and door insulation of at least R-25 (R-4.4) and walk-in freezers at least R-32 (R-5.6).

Exception to 6.4.5c: Glazed portions of doors or structural members.

d. Walk-in freezers shall contain floor insulation of at least R-28 (R-4.9).

e. Evaporator fan motors that are less than 1 hp (75 kW) and less than 460 V shall use electronically commutated motors (brushless direct-current motors) or three-phase motors.

f. Lights shall use light sources with an efficacy of 40 lm/W or more, including ballast losses (if any). Light sources with an efficacy of less than 40 lm/W, including ballast losses (if any), may be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the walk-in cooler or walk-in freezer is not occupied by people.

g. Transparent reach-in doors for walk-in freezers, and windows in walk-in freezer doors, shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

h. Transparent reach-in doors for walk-in coolers, and windows in walk-in cooler doors, shall be double-pane glass with heat-reflective treated glass and gas filled, or they shall be triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

i. Anti-sweat heaters without anti-sweat heater controls shall have a total door rail, glass, and frame heater power draw of ≤7.1 W/ft^2 (≤76 W/m^2) of door opening for walk-in freezers and 3.0 W/ft^2 (32 W/m^2) of door opening for walk-in coolers.

j. Anti-sweat heater controls shall reduce the energy use of the anti-sweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

k. Condenser fan motors that are less than 1 hp shall use electronically commutated motors, permanent split capacitor-type motors or three-phase motors.

Exception: Walk-in coolers and walk-in freezers combined in a single enclosure greater than 3000 ft^2 (280 m^2).

6.5.10 Refrigeration Systems. Refrigeration systems that are comprised of refrigerated display cases, walk-in coolers, or walk-in freezers connected to remote compressors and remote condensers, not in a condensing unit, shall meet the requirements of Sections 6.5.10.1 through 6.5.10.2.

Exception: Systems utilizing transcritical refrigeration cycle.

6.5.10.1 Condensers. Fan-powered condensers shall conform to the following requirements:

a. Design saturated condensing temperatures for air-cooled condensers shall be less than or equal to the design dry-bulb temperature plus 10°F (5.5°C) for low-temperature refrigeration systems and less than or equal to the design dry-bulb temperature plus 15°F (8°C) for medium-temperature refrigeration systems.

b. Condenser fan motors that are less than 1 hp (75 kW) shall use electronically commutated motors, permanent split capacitor-type motors, or three-phase motors.

6.5.10.2 Refrigeration System Design. Refrigeration systems shall be designed for minimum saturated condensing temperature setpoint ≤70°F (≤21°C).

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

FOREWORD

The wording of Standard 90.1-2010 limits simultaneous heating and cooling in zone controls, hydronic systems, dehumidification systems, and humidification systems. The existing wording does not limit simultaneous heating and cooling in some air-handling equipment serving multiple zones. This addendum is intended to limit some of these cases.

Some air-handling systems consume large amounts of heating energy when in economizer mode. A common example is that a hospital may have a discharge air temperature setpoint of 52°F but have so much heat generated by devices such as integral face and bypass heating coils and humidifier bayonets that it may be in 100% economizer mode when the outdoor air temperature is below 40°F. A 100,000 cfm air-handling system with 20°F of unintended heating would consume over two million Btu/h when it was theoretically in free cooling mode. In this situation, the humidification load would also approximately triple because of the increase in outdoor airflow rate.

One consequence of this addendum is that manufacturers of preheat coils would be required to design them such that the heating control valve can be closed when heat is not required, even during cold weather.

Note: *In this addendum, changes to the current standard are indicated in the text by* underlining *(for additions) and* ~~strikethrough~~ *(for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum as to Standard 90.1-2010

Revise Section 6 as follows (I-P units).

~~**6.4.3.6 Humidifier Preheat.** Humidifiers with preheating jackets mounted in the airstream shall be provided with an automatic valve to shut off preheat when humidification is not required.~~

6.5.2.4 Humidification

6.5.2.4.1 Systems with hydronic cooling and humidification systems designed to maintain inside humidity at a dew-point temperature greater than 35°F shall use a water *economizer* if an *economizer* is required by Section 6.5.1.

6.5.2.4.2 Humidifiers with preheating jackets mounted in the airstream shall be provided with an automatic valve to shut off preheat when humidification is not required.

6.5.2.4.3 Humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units shall be insulated with a product with an insulating value of at least R-0.5.

Exception: Systems where *mechanical cooling*, including *economizer* operation, does not occur simultaneously with humidification.

6.5.2.5 Preheat Coils. Preheat coils shall have controls that stop their heat output whenever *mechanical cooling*, including *economizer* operation, is occurring.

Revise Section 6 as follows (SI units).

~~**6.4.3.6 Humidifier Preheat.** Humidifiers with preheating jackets mounted in the airstream shall be provided with an automatic valve to shut off preheat when humidification is not required.~~

6.5.2.4 Humidification

6.5.2.4.1 Systems with hydronic cooling and humidification systems designed to maintain inside humidity at a dew-point temperature greater than 2°C shall use a water *economizer* if an *economizer* is required by Section 6.5.1.

6.5.2.4.2 Humidifiers with preheating jackets mounted in the airstream shall be provided with an automatic valve to shut off preheat when humidification is not required.

6.5.2.4.3 Humidification system dispersion tube hot surfaces in the airstreams of ducts or air-handling units shall be insulated with a product with an insulating value of at least R-0.09.

Exception: Systems where *mechanical cooling*, including *economizer* operation, does not occur simultaneously with humidification.

6.5.2.5 Preheat Coils. Preheat coils shall have controls that stop their heat output whenever *mechanical cooling*, including *economizer* operation, is occurring.

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

FOREWORD

Addendum ds to Standard 90.1-2010 used the term daylight area under clerestories *instead of* under roof monitors. *Though the* IES Handbook *uses this term, it actually is an ambiguous term as it is often used to refer to windows high up on a wall, but it can also refer to monitor windows projecting from the roof. However, the opposite is not true in that the term* roof monitor *does not refer to windows high up on a wall. In addition, Addendum ds combined the terms* roof monitor *and* clerestory *in the same definition without clear guidance which is which. This addendum clarifies the use by removing the term* clerestory *and consistently using the term* roof monitor*.*

***Note:** In this addendum, changes to the current standard are indicated in the text by* underlining *(for additions) and* ~~strikethrough~~ *(for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum at to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

3.2 Definitions

~~***clerestory:*** that part of a building that rises clear of the roofs or other parts and whose walls contain windows for lighting the interior.~~

~~***rooftop monitors:*** *vertical fenestration* integral to the roof.~~

roof monitor: that part of a *building* that projects above the plane of the *roof* and whose walls contain *vertical fenestration* for lighting the interior.

fenestration: all areas (including the frames) in the *building envelope* that let in light, including windows, plastic panels, clerestories, *roof monitors*, *skylights*, doors that are more than one-half glass, and glass block walls. (See *building envelope* and *door*.)

daylight area:

...

b) ***under ~~clerestories~~ roof monitors:*** the *daylight area under ~~clerestories~~ roof monitors* is the combined *daylight area* under each ~~*clerestory*~~ ~~or~~ *roof~~top~~ monitor* without double counting overlapping areas. The daylight area under each ~~*clerestory*~~ ~~or~~ *roof~~top~~ monitor* is the product of the daylight area width under roof monitors and the daylight area depth under roof monitors. The daylight area width under roof monitors is the width of the *vertical fenestration* above the ceiling level plus, on each side, the smallest of ~~2 feet (0.6 m) on each side, multiplied by the~~

1. 2 ft (0.6 m) or
2. the distance to any 60 in. (1.5 m) or higher vertical obstruction or
3. the distance to the edge of any primary sidelighted area.

The daylight area depth under roof monitors is the smallest of the following horizontal distances inward from the bottom edge of the ~~glazing~~ *vertical fenestration* (see Figure 3.2):

1. the monitor sill height, MSH (the vertical distance from the floor to the bottom edge of the monitor glazing), or
2. the distance to the edge of any *primary sidelighted area* or
3. the distance to the front face of any vertical obstruction where any part of the obstruction is farther away than the difference between the height of the obstruction and the monitor sill height (MSH · OH).

Replace all references to "rooftop monitors" with "roof monitors" as follows.

***toplighting*:** lighting *building* interiors with daylight admitted through *fenestration* located on the roof such as *skylights* and *roof~~top~~ monitors*.

5.5.4.2.3 Minimum *Skylight* Fenestration Area.

....

Exceptions to Section 5.5.4.2.3:

a. *Enclosed spaces* in climate zones 6 through 8.
b. *Enclosed spaces* with designed *general lighting* power densities less than 0.5 W/ft^2.
c. *Enclosed spaces* where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the *enclosed space* for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.
d. *Enclosed spaces* where the *daylight area under roof~~top~~ monitors* is greater than 50% of the *enclosed space* floor area.

9.4.1.5 Automatic Daylighting Controls for *Toplighting*. When the total *daylight area under skylights* plus the total *daylight area under ~~clerestories~~ roof monitors* in an *enclosed space* exceeds 900 ft^2, the lamps for *general lighting* in the *daylight area* shall be separately controlled by at least one multilevel photocontrol (including continuous dimming devices) having the following characteristics:

...

Replace Figure 3.2 with the figure provided in this addendum and change the caption for Figure 3.2 as indicated.

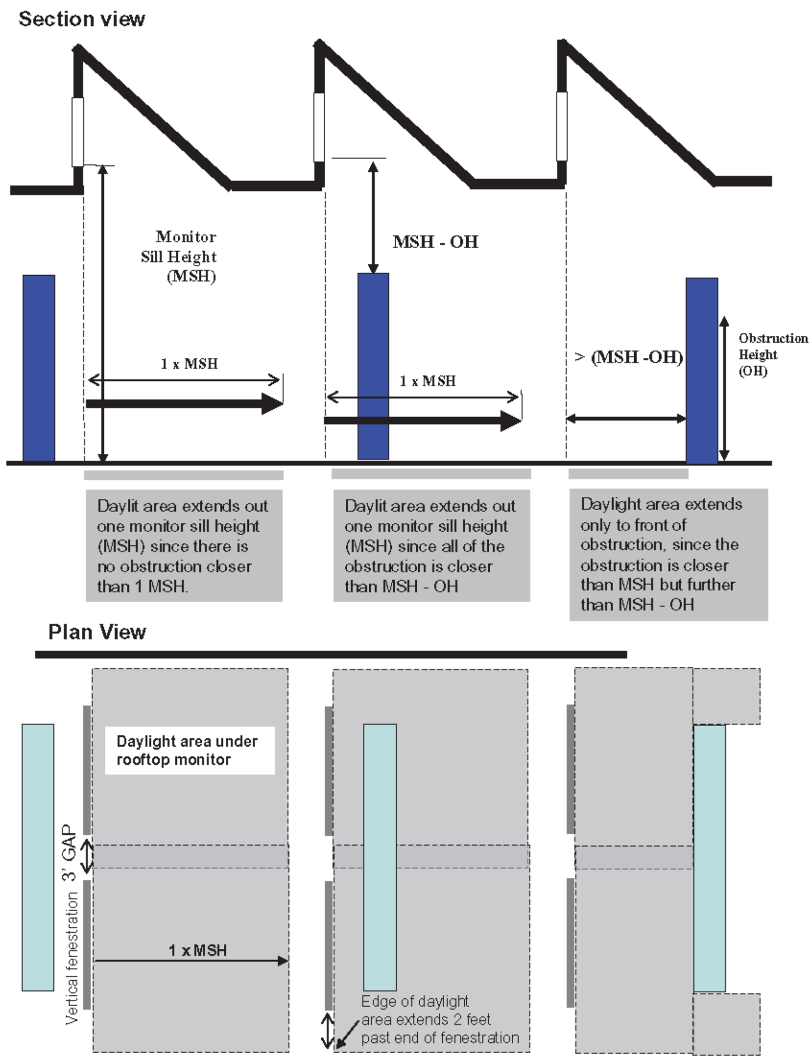

Figure 3.2 ~~**Computing the**~~<u>**Section and plan view of**</u> ***daylight area under roof monitors*****.**

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

FOREWORD

This addendum does the following:

- *Adds a requirement that the sound attenuation credit is only available if there are background noise criteria requirements.*
- *Adds a deduction for systems without any central heating or cooling device. Since the base-level fan power allowances include the assumption that those components are present, the deduction is warranted for those systems that do not include those component.*
- *Adds a deduction for systems with electric resistance heating. Since the base-level fan power allowances include the assumption that hydronic heating coils are present, systems with electric resistance heating coils that have less pressure drop do not need the full allowance assumed in the base level.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum au to Standard 90.1-2010

Revise the standard as follows for SI and I-P units.

TABLE 6.5.3.1.1B Fan Power Limitation Pressure Drop Adjustment

Device	Adjustments
Credits	
Sound Attenuation Section (fans serving spaces with design background noise goals below NC35)	0.15 in. wc
Deductions	
Systems without central cooling device	–0.6 in. wc (150 Pa)
Systems without central heating device	–0.3 in. wc (75 Pa)
Systems with central electric resistance heat	–0.2 in. wc (50 Pa)

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FOREWORD

The SSPC included data centers within the scope of Standard 90.1-2010. A significant factor was to require data centers to have economizers (air or water side) based on the exceptions listed in Section 6.5.1. The inclusion of Section 6.5.1 exception k was a means to include computer rooms and data centers into Standard 90.1-2010 from all interested parties, including TC9.9. The exceptions as listed for economizers are intended for a small subset of industry data centers that are required to go to greater lengths to comply with other industry regulations, codes, and/or other standards in order to ensure reliable operations of those mission critical facilities and their associated services, which if interrupted could create substantial systemic risk, compromise public safety, and/or otherwise interrupt services vital to national security, financial stability, commerce, and communications. This change is an effort to make the economizer exceptions more strict and is in agreement with TC 9.9.

ANSI

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum av to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

6.5.1 Economizers [. . .]

Exceptions:

k. Dedicated systems for *computer rooms* where a minimum of 75% of the design load serves:

[. . .]

2. those spaces having a ~~mechanical cooling~~ design of Tier IV as defined by ANSI/TIA-942

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FOREWORD

This references the latest edition of ANSI/ASHRAE Standard 140, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifi-

Addendum aw to Standard 90.1-2010

Update Section 11.2.1.4 as follows.

11.2.1.4 The simulation program shall be tested according to ASHRAE Standard 140, except Sections 7 and 8, and the results shall be furnished by the software provider.

Update Section G2.2.4 as follows.

G2.2.4 The simulation program shall be tested according to ASHRAE Standard 140, except Sections 7 and 8, and the results shall be furnished by the software provider.

Update Section 12 as follows.

Reference	Title
American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1791 Tullie Circle, NE, Atlanta, GA 30329	
ANSI/ASHRAE Standard 140-~~2004~~2011	Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs

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

FOREWORD

This addendum requires that all shading by adjacent structures be modeled per G3.1 part 14a.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ax to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
14.	**Exterior Conditions**	
a.	**Shading by adjacent structures and terrain:** The effect that structures and significant vegetation or topographical features have on the amount of solar radiation being received by a structure shall be adequately reflected in the computer analysis. All elements whose effective height is greater than their distance from a proposed building and whose width facing the proposed building is greater than one-third that of the proposed building shall be accounted for in the analysis. ~~If the computer program has a subroutine to simulate shading by adjacent structures, then this option shall be used. If the computer program does not have a subroutine to simulate shading by adjacent structures, then any portion of a structure that is shaded most of the time is allowed to be modeled as having a north-facing orientation.~~	Same as Proposed Design.
b.	**Ground temperatures for below-grade wall and basement floor heat loss calculations:** It is acceptable to use either an annual average ground temperature or monthly average ground temperatures for calculation of heat loss through below-grade walls and basement floors.	
c.	**Water main temperatures for service water heating calculations:** It is acceptable to use either an annual water main supply temperature or monthly average water main supply temperatures for calculating service water heating. If annual or monthly water main supply temperatures are not available from the local water utility, annual average ground temperatures may be used.	

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

FOREWORD

This revision of the daylighting requirements incorporates additional energy-saving measures and provides clarification and simplification. Specifically, the revision

- *changes the thresholds for applying daylighting controls to a wattage-controlled basis, which applies to more spaces in a buildings for additional energy savings;*
- *simplifies the delineation of daylight zones and clarifies area calculations;*
- *eliminates the need for effective aperture calculation; and*
- *is based on extensive, cost-effective application analysis.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ay to Standard 90.1-2010

Revise Section 3 as follows (I-P and SI). Note: Figures 3.1 through 3.4 replace those found in Standard 90.1-2010.

3.2 Definitions

[. . .]

~~***daylight area:***~~

~~a. ***under skylights:*** the daylight area under skylights is the combined daylight area under each skylight without double counting overlapping areas. The daylight area under each skylight is bounded by the opening beneath the skylight, plus horizontally in each direction, the smallest of (See Figure 3.1)~~

~~1. 70% of the ceiling height (0.7 × CH), or~~

~~2. the distance to any primary sidelighted area, or the daylight area under rooftop monitors, or~~

~~3. the distance to the front face of any vertical obstruction where any part of the obstruction is farther away than 70% of the distance between the top of the obstruction and the ceiling (0.7 × [CH– OH]), where CH = the height of the ceiling at the lowest edge of the skylight, and OH = the height to the top of the obstruction.~~

~~b. ***under rooftop monitors:*** the daylight area under rooftop monitors is the combined daylight area under each rooftop monitor without double counting overlapping ares. The daylight area under each rooftop monitor is the product of the width of the vertical glazing above the ceiling level and the smallest of the following horizontal distances inward from the bottom edge of the glazing, (See Figure 3.2):~~

~~1. the monitor sill height, MSH, (the vertical distance from the floor to the bottom edge of the monitor glazing), or~~

~~2. the distance to the edge of any primary sidelighted area or~~

~~3. the distance to the front face of any vertical obstruction where any part of the obstruction is farther away than the difference between the height of the obstruction and the monitor sill height (MSH-OH).~~

~~***primary sidelighted area:*** the total primary sidelighted area is the combined primary sidelighted area without double counting overlapping areas. The floor area for each primary sidelighted area is directly adjacent to vertical fenestration below the ceiling with an area equal to the product of the primary side-lighted area width and the primary sidelighted area depth. See Figure 3.3.~~

~~The primary sidelighted area width is the width of the vertical fenestration plus, on each side, the smallest of:~~

~~1. 2 ft or~~
~~2. the distance to any 5 ft or higher vertical obstruction.~~

~~The primary sidelighted area depth is the horizontal distance perpendicular to the vertical fenestration which is the smaller of:~~

~~1. one vertical fenestration heat height (head height is the distance from the floor to the top of the glazing), or~~
~~2. the distance to any 5 ft or higher vertical obstruction.~~

~~***secondary sidelighted area:*** the total secondary sidelighted area is the combined secondary sidelighted area without double counting overlapping areas. The floor area for each secondary sidelighted area is directly adjacent to a primary sidelighted area with an area equal to the product of the secondary sidelighted area width and the secondary sidelighted area depth. See Figure 3.4.~~

~~The secondary sidelighted area width is the width of the vertical fenestration plus, on each side, the smallest of:~~

~~a. 2 ft, or~~
~~b. the distance to any 5 ft or higher vertical obstruction.~~

~~The secondary sidelighted area depth is the horizontal distance perpendicular to the vertical fenestration which begins at the edge of the primary sidelighted area depth and ends at the smaller of:~~

~~1. one vertical fenestration head height (head height is the distance from the floor to the top of the glazing), or~~
~~2. the distance to any 5 ft or higher vertical obstruction.~~

~~If the adjacent primary sidelighted area ends at a 5 ft or higher vertical obstruction or beyond the nearest edge of a neighboring daylight area under skylight or primary sidelighted area,~~

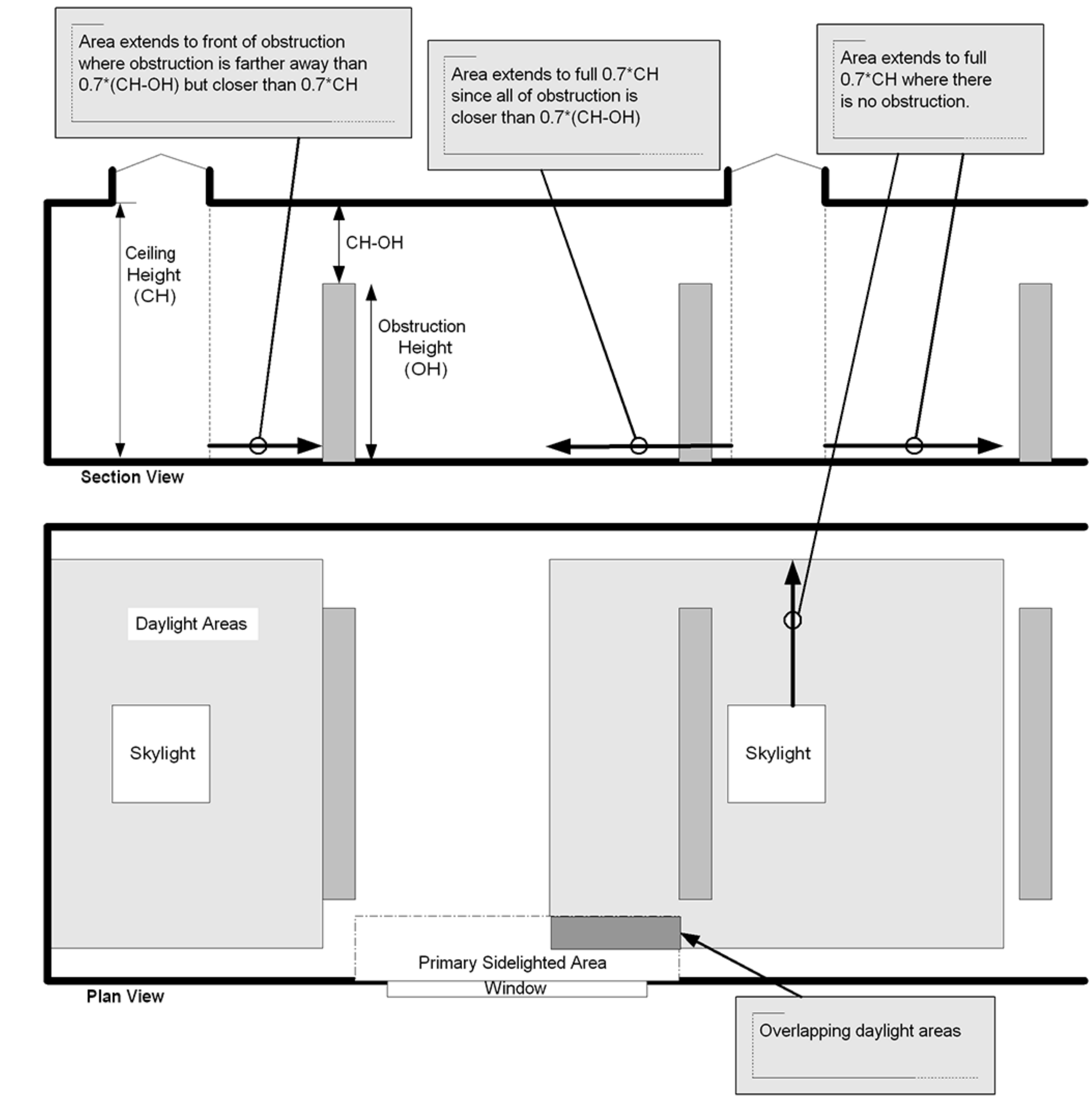

Figure 3.1 Computing the daylight area under skylights.

~~there is no secondary sidelighted area beyond such obstruction or the edge of such areas.~~

~~***sidelighting effective aperture:*** relationship of daylight transmitted through windows to the primary sidelighted areas. The sidelighting effective aperture is calculated according to the following formula:~~

$$\text{Sidelighting Effective Aperture} = \frac{\sum \text{Window area} \times \text{Window VT}}{\text{area of primary sidelighted area}}$$

~~where window VT is the visible transmittance of windows as determined in accordance with Section 5.8.2.6.~~

daylight area:

daylight area under roof monitors: the daylight area under roof monitors is the combined daylight area under each roof monitor within each space. The daylight area under each roof monitor is the product of

a. the width of the vertical fenestration above the ceiling level plus, on each side, the smallest of
   1. 2 ft (0.6 m),
   2. the distance to any 5 ft (1.5 m) or higher vertical obstruction, or
   3. the distance to the edge of any primary sidelighted area

and

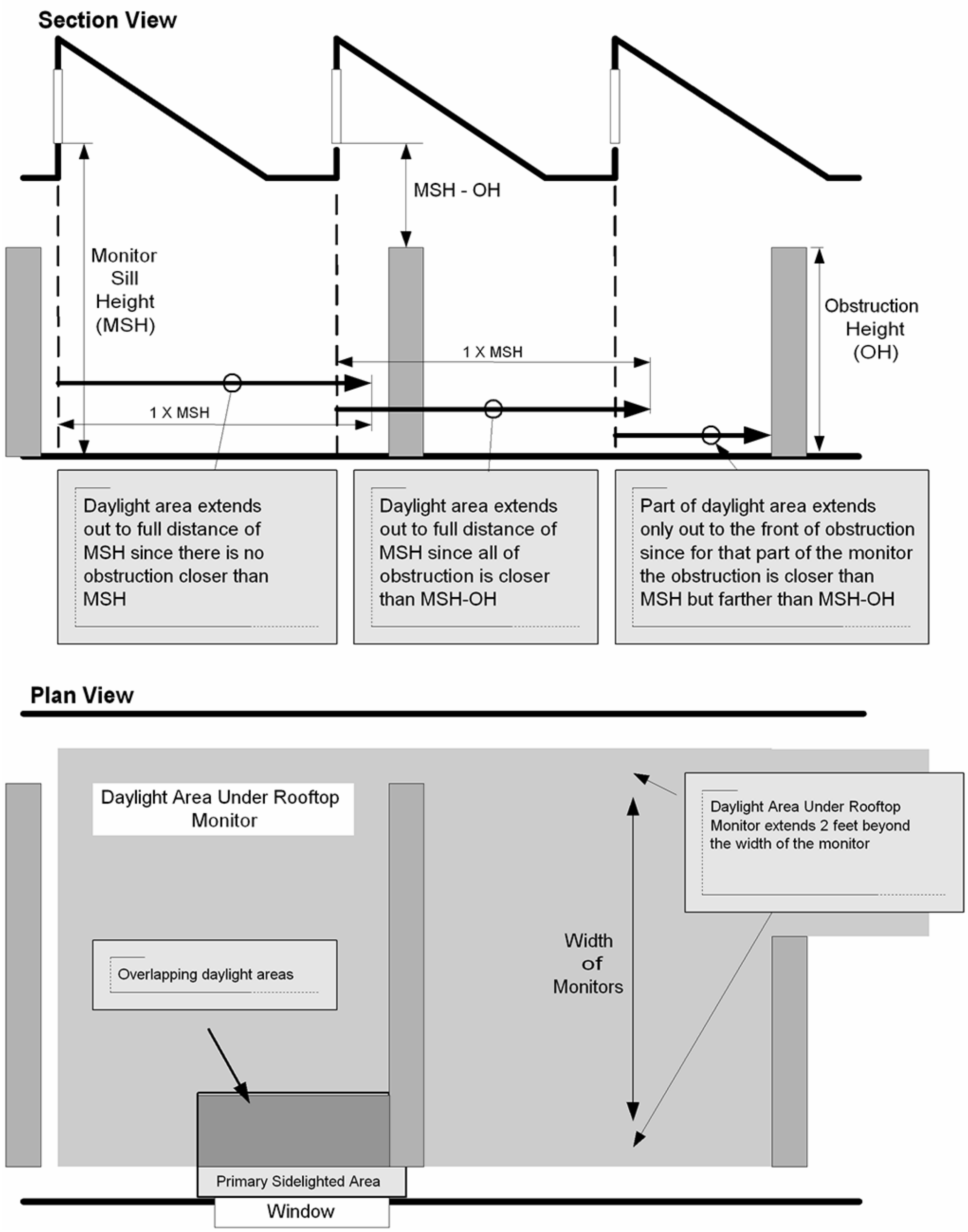

Figure 3.2 Computing the daylight area under roof monitors.

b. the smaller of the following horizontal distances inward from the bottom edge of the vertical fenestration (see Figure 3.2):

1. the monitor sill height (MSH) (the vertical distance from the floor to the bottom edge of the monitor glazing) or
2. the distance to the nearest face of any opaque vertical obstruction, where any part of the obstruction is farther away than the difference between the height of the obstruction and the monitor sill height (MSH – OH).

daylight area under skylights: the daylight area under skylights is the combined daylight area under each skylight within a space. The daylight area under each skylight is bounded by the opening beneath the skylight and horizontally in each direction, the smaller of (see Figure 3.1)

a. 70% of the ceiling height (0.7 × CH), or

b. the distance to the nearest face of any opaque vertical obstruction, where any part of the obstruction is farther away than 70% of the distance between the top of the obstruction and the ceiling (0.7 × [CH – OH], where CH = the height of the ceiling at the lowest edge of the skylight and OH = the height to the top of the obstruction).

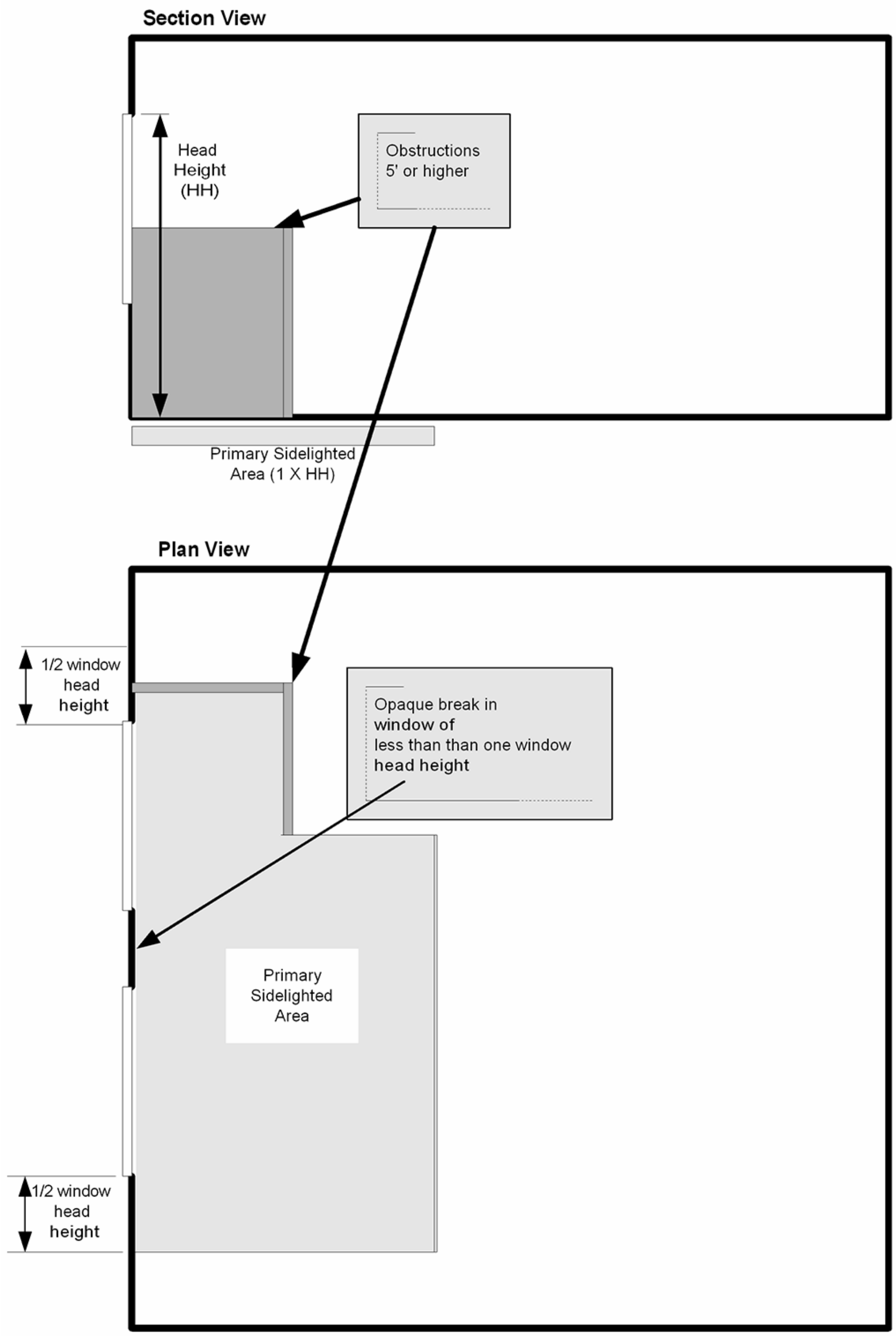

Figure 3.3 Computing the primary sidelighted area.

primary sidelighted area: the total primary sidelighted area is the combined primary sidelighted area within each space. Each primary sidelighted area is directly adjacent to vertical fenestration below the ceiling (see Figure 3.3).

a. The primary sidelighted area width is the width of the vertical fenestration plus, on each side, the smaller of

1. one half of the vertical fenestration head height (where head height is the distance from the floor to the top of the glazing) or

2. the distance to any 5 ft (1.5 m) or higher opaque vertical obstruction.

b. The primary sidelighted area depth is the horizontal distance perpendicular to the vertical fenestration which is the smaller of

1. one vertical fenestration head height or

2. the distance to any 5 ft (1.5 m) or higher opaque vertical obstruction.

secondary sidelighted area: the total secondary sidelighted area is the combined secondary sidelighted area within a space. Each secondary sidelighted area is directly adjacent to a primary sidelighted area (see Figure 3.4):

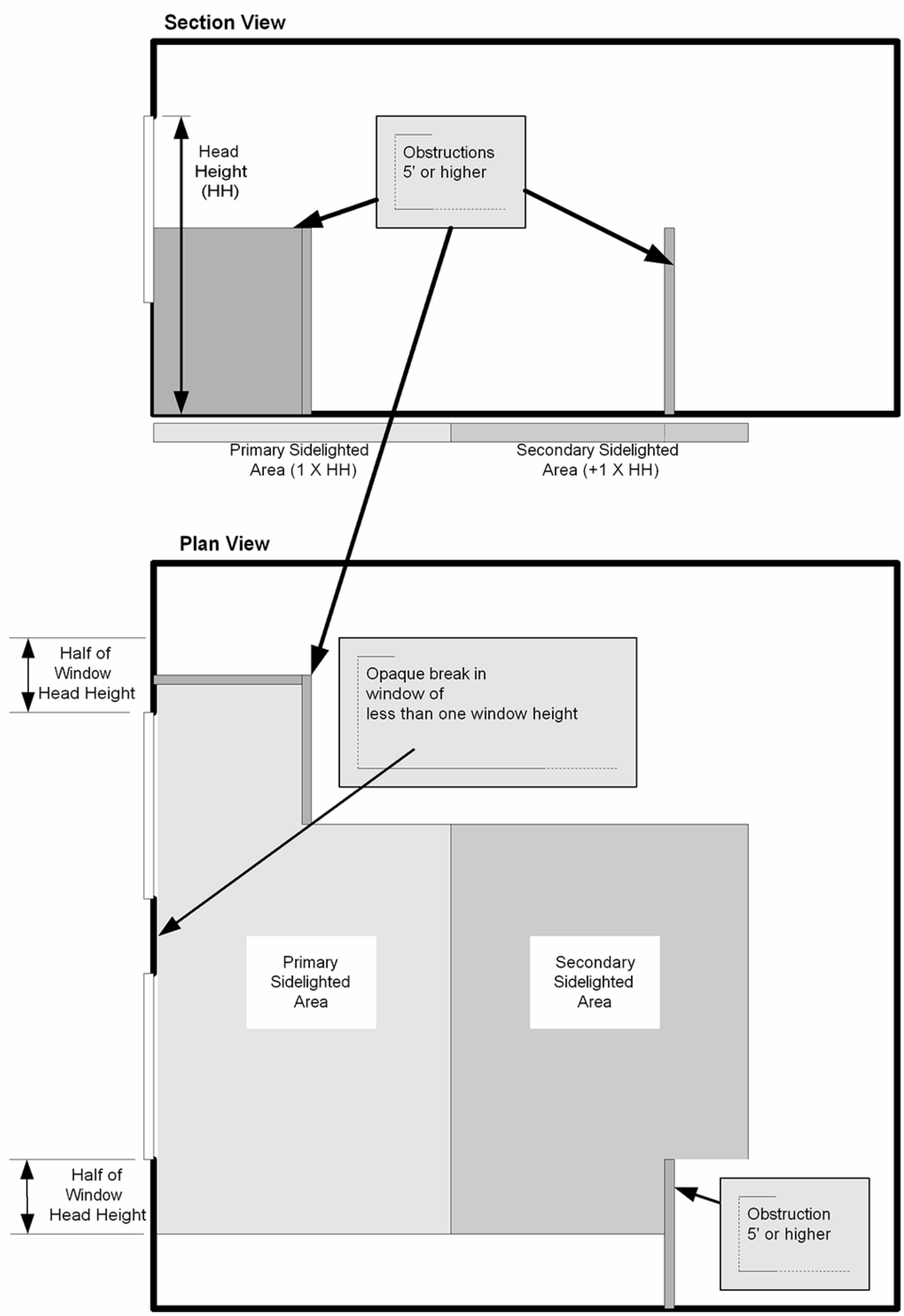

Figure 3.4 Computing the secondary sidelighted area.

a. The secondary sidelighted area width is the width of the vertical fenestration plus, on each side, the smaller of

1. one half of the vertical fenestration head height or
2. the distance to any 5 ft (1.5 m) or higher opaque vertical obstruction.

b. The secondary sidelighted area depth is the horizontal distance perpendicular to the vertical fenestration, which begins at the edge of the primary sidelighted area depth and ends at the smaller of

1. one vertical fenestration head height or
2. the distance to any 5 ft (1.5 m) or higher opaque vertical obstruction.

If the adjacent primary sidelighted area ends at a 5 ft (1.5 m) or higher opaque vertical obstruction, there is no secondary sidelighted area beyond such obstruction.

Revise Section 5 as follows (I-P and SI).

5.7 Submittals

[. . .]

5.7.4 Submittal Documentation of Daylight Areas. Daylighting documentation shall identify daylight areas on floor plans, including the primary sidelighted areas, secondary sidelighted areas, daylight areas under skylights, and daylight areas under roof monitor.

Revise Section 9 as follows (I-P and SI).

~~**9.4.1.4 Automatic Daylighting Controls for Primary Sidelighted Areas.** When the combined primary sidelighted area in an enclosed space equals or exceeds 250 ft^2, the lamps for general lighting in the primary sidelighted area shall be separately controlled by at least one multilevel photocontrol (including continuous dimming devices) having the following characteristics:~~

a. ~~The light sensor for the photocontrol shall be remote from where calibration adjustments are made.~~
b. ~~The calibration adjustments shall be readily accessible.~~
c. ~~The multilevel photocontrol shall reduce electric lighting in response to available daylight with at least one control step that is between 50% and 70% of design lighting power and another control step that is no greater than 35% (including off) of design power.~~

~~**Exceptions:**~~

a. ~~Primary sidelighted areas where the top of the existing adjacent structures are twice as high above the windows as their distance away from the windows.~~
b. ~~Primary sidelighted areas where the sidelighting effective aperture is less than 0.1 (10%).~~
c. ~~Retail spaces.~~

~~**9.4.1.5 Automatic Daylighting Controls for Toplighting.** When the total daylight area under skylights plus the total daylight area under rooftop monitors in an enclosed space exceeds 900 ft^2, the lamps for general lighting in the daylight area shall be separately controlled by at least one multilevel photocontrol (including continuous dimming devices) having the following characteristics:~~

a. ~~The light sensor for the photocontrol shall be remote from where calibration adjustments are made.~~
b. ~~The calibration adjustments shall be readily accessible.~~
c. ~~the multilevel photocontrol shall reduce electric lighting in response to available daylight with at least one control step that is between 50% and 70% of design lighting power and another control step that is no greater than 35% of design power.~~

~~**Exceptions:**~~

a. ~~Daylighted areas under skylights where it is documented that existing adjacent structures or natural objects block direct beam sunlight for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.~~
b. ~~Daylighted areas where the skylight effective aperture (EA) is less than 0.006 (0.6%).~~
c. ~~Buildings in Climate Zone 8 with daylight areas totaling less than 1500 ft^2 in an enclosed space.~~

9.4.1.4 Automatic Daylighting Controls for Sidelighting

a. In any space where the combined input power of all general lighting completely or partially within the primary sidelighted areas is 150 W or greater, the general lighting in the primary sidelighted areas shall be controlled by photocontrols.
b. In any space where the combined input power of all general lighting completely or partially within the primary and secondary sidelighted areas is 300 W or greater, the general lighting in the primary sidelighted areas and secondary sidelighted areas shall be controlled by photocontrols.
c. The control system shall have the following characteristics:
   1. The calibration adjustments shall be readily accessible.
   2. At a minimum, general lighting in the secondary sidelighted area shall be controlled independently of the general lighting in the primary sidelighted area.
   3. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or by having at least one control point between 50% and 70% of design lighting power, a second control point between 20% and 40% of design lighting power, and a third control point that turns off all the controlled lighting.

Exceptions to Sections 9.4.1.4a and 9.4.1.4b:

a. Primary sidelighted areas where the top of the existing adjacent structures are twice as high above the windows as their distance away from the windows.
b. Sidelighted areas where the total glazing area is less than 20 ft^2 (1.9 m^2).
c. Retail spaces.

9.4.1.5 Automatic Daylighting Controls for Toplighting. In any space where the combined input power for all general lighting completely or partially within daylight areas under skylights and daylight areas under roof monitors is 150 W or greater, general lighting in the daylight area shall be controlled by photocontrols having the following characteristics:

a. The calibration adjustments shall be readily accessible.
b. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or by having at least one control point that is between 50% and 70% of design lighting power, a second control point between 20% and 40% of design lighting power, and a third control point that turns off all the controlled lighting.
c. General lighting in overlapping toplighted and sidelighted daylight areas shall be controlled together with

general lighting in the daylight area under skylights or daylight areas under roof monitors.

Exceptions to Section 9.4.1.5:

a. Daylight areas under skylights where it is documented that existing adjacent structures or natural objects block direct beam sunlight for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

b. Daylight areas where the skylight visible transmittance (VT) is less than 0.4.

c. In each space within buildings in Climate Zone 8 where the input power of the general lighting within daylight areas is less than 200 W.

[. . .]

9.7.2.3 Daylighting Documentation. The design documents shall identify all luminaires for general lighting that are located within daylight areas under skylights, daylight areas under roof monitors as well as primary sidelighted areas and secondary sidelighted areas.

Revise Table 9.6.2 as follows (I-P and SI).

TABLE 9.6.2 Control Factors Used in Calculating Additional Interior Lighting Power Allowance (I-P)

Additional Control Method (in Addition to Mandatory Requirements).	Space Type				
	Open Office	Private Office	Conference Room, Meeting Room, Classroom (Lecture/ Training)	Retail Sales Area	Lobby, Atrium, Dining Area, Corridors/ Stairways, Gym/ Pool, Mall Concourse, Parking Garage
Manual, continuous dimming control or Programmable multi-level dimming control	0.05	0.05	0.10[1]	0.10	0
Programmable multi-level dimming control using programmable time scheduling	0.05	0.05	0.10[1]	0.10	0.10
Multi-level occupancy sensors	0.05	0.05	0.05	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off capabilities.	0.25[2]	0	0	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off operation, in combination with personal continuous dimming control of downlight illumination by workstation occupant.	0.30[2,3]	0	0	0	0
Automatic ~~bi-level switching, or~~ multilevel switching or continuous dimming in primary and secondary sidelighted areas ~~when sidelighting effective aperture is greater than 0.15~~.	0	0	0	0.10[4]	0
Automatic ~~bi-level or~~ multilevel switching or continuous dimming in primary sidelighted areas when ~~sidelighting effective aperture is greater than 0.15 and when~~ the controlled watts are less than 120 W in the primary sidelighted area ~~is less than 250 ft2 (23 m2)~~ or less than 240 W in the combined primary and secondary sidelighted areas.	0.10[4]	0.10[4]	0.10[4]	0.10[4]	0.10[4]
~~Automatic continuous daylight dimming in primary sidelighted areas when sidelighting effective aperture is greater than 0.15 and when primary sidelighted area is less than 250 ft² (23 m²)~~	~~0.20~~[4]	~~0.20~~[4]	~~0.20~~[4]	~~0.20~~[4]	~~0.20~~[4]
~~Automatic continuous daylight dimming in primary sidelighted areas when sidelighting effective aperture is greater than 0.15 and when primary sidelighted area is greater than 250 ft² (23 m²).~~	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]
~~Automatic continuous daylight dimming in secondary sidelighted areas when sidelighting effective aperture is greater than 0.3.~~	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]	~~0.10~~[4]
Automatic continuous daylight dimming in daylighted areas under skylights ~~when the total of those areas is less than 900 ft² (84 m²) and when skylight effective aperture is greater than 0.01~~ when the controlled watts are less than 120 W and when the skylight transmittance (VT) is greater than 0.4.	0.20	0.20	0.20	0.20	0.20
~~Automatic continuous daylight dimming in daylighted areas under skylights when the total of those areas is greater than 900 ft2 (84 m2) and when skylight effective aperture is greater than 0.01~~	~~0.10~~	~~0.10~~	~~0.10~~	~~0.10~~	~~0.10~~

1. These control factors may only be used if the requirements of Section 9.4.1.2 are met using an occupancy sensor.
2. Control factor is limited to workstation-specific luminaires in partitioned single occupant work spaces contained within an open office environment (i.e. direct-indirect luminaires with separately controlled downlight and uplight components, with the downward component providing illumination to a single occupant in an open plan workstation). Within 30 minutes of the occupant leaving the space, the downward component shall continuously dim to off over a minimum of 2 minutes. Upon the occupant entering the space, the downward component shall turn on at the minimum level and continuously raise the illumination to a preset level over a minimum of 30 seconds. The uplight component of workstation specific luminaire shall comply with Section 9.4.1.1 (automatic shutoff).
3. In addition to the requirements described in footnote 2, the control shall allow the occupant to select their preferred light level via a personal computer, handheld device, or similarly accessible device located within the workstation.
4. Control factors may not be used if controls are used to satisfy exceptions to Section 5.5.4.2.3

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

FOREWORD

Evaporatively cooled heat rejection devices are a key part of the most efficient cooling systems on the market. An increase in the minimum efficiency of open-circuit axial-fan cooling towers from the current 38.2 gpm/HP to 40.2 gpm/HP (at the rated condition of 95°F entering water temperature, 85°F leaving water temperature, and 75°F entering wet-bulb temperature) is proposed to further increase the overall system efficiency. Such an increase will remove many of the lower-efficiency models off of the market without unnecessarily causing market shifts due to first-cost pressures in the absence of a limitation on the use of lower-efficiency systems in the standard.

In addition, a note has been added to Table 6.8.1G clarifying that the required minimum efficiency rating for all types of cooling towers (open, closed, axial fan, and centrifugal fan) applies to models with options and accessories that affect the thermal performance of the unit, not just the base model. This requirement complies with the Cooling Technology Institute's STD-201, which states that a base model with options and/or accessories that affect thermal performance are classified as a separate model for rating and certification purposes. For instance, a base tower model equipped with a low-sound fan that has a derate of 2% from the base model equipped with a standard fan must still meet the minimum efficiency listed in Table 6.8.1.G, even when the reduced thermal capacity is taken into account. This new note will clarify this requirement for users of the standard and will result in additional energy savings by eliminating the use of those models whose base configuration may meet the minimum efficiency requirement listed in Table 6.8.1G, but the rating falls below the required minimum efficiency when rated with the thermal effect of options and accessories required for a specific project.

Lastly, a note clarifying that the certification requirements do not apply to field-erected cooling towers was added to footnote "e".

This addendum has received the unanimous support of ASHRAE TC08.06, Cooling Towers and Evaporative Condensers.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum az to Standard 90.1-2010

Revise the Standard as follows I-P units.

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c,d,f]	Test Procedure[e]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F *entering wb*	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F *entering wb*	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F *entering wb*	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F *entering wb*	≥7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air-cooled condensers	All	125°F condensing temperature R-22 test fluid 190°F entering gas temperature 15°F subcooling 95°F *entering db*	≥176,000 Btu/h·hp	AHRI 460

[a] For purposes of this table, *open-circuit cooling tower* performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan motor nameplate power.

[b] For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

[c] For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

[d] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

[e] The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.

[f] All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.

Revise the Standard as follows SI units.

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c,d,f]	Test Procedure[e]
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C *entering wb*	≥3.23 L/s·kW	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C *entering wb*	1.7 L/s·kW	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C *entering wb*	1.18 L/s·kW	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C *entering wb*	≥0.59 L/s·kW	CTI ATC-105S and CTI STD-201
Air-cooled condensers	All	52°C condensing temperature R-22 test fluid 88°C entering gas temperature 8°C subcooling 35°C *entering db*	69 COP	AHRI 460

[a] For purposes of this table, *open-circuit cooling tower* performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan motor nameplate power.

[b] For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

[c] For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

[d] Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

[e] The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field-erected cooling towers.

[f] All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.

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

FOREWORD

When a space with operable windows has nonintegrated mechanical heating and cooling, it is likely that annual HVAC energy will be increased when compared to the same space without operable doors. This can be attributed to operable doors being left open when conditions are not favorable, resulting in high infiltration loads on the HVAC system.

The intent of this addendum is to reduce unnecessary use of energy for heating or cooling of additional untempered air if an operable door is left open outside of times when it is beneficial to leave it open. This is accomplished with a simple mechanical switch that integrates the HVAC system operation with operable door position.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ba to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

6.3.2 Criteria

[. . .]

r. The system complies with the door switch requirements in Section 6.5.10.

[. . .]

6.5.10 Door Switches. Any conditioned space with a door, including doors with more than one-half glass, opening to the outdoors shall be provided with controls that, when any such door is open,

a. disable mechanical heating or reset the heating setpoint to 55°F (13°C) or lower within five minutes of the door opening and
b. disable mechanical cooling or reset the cooling setpoint to 90°F (32°C) or greater within five minutes of the door opening. Mechanical cooling may remain enabled if outdoor air temperature is below space temperature.

Exceptions:

a. Building entries with automatic closing devices
b. Any space without a thermostat
c. Alterations to existing buildings
d. Loading docks

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

FOREWORD

This addendum updates the building envelope requirements for opaque elements and fenestration in Standard 90.1-2010. There are also text and appendix changes that relate to the prescriptive criteria tables. In summary, the text changes are as follows.

1. *Section 3, the definitions for fenestration were expanded and moved from the Table 5.5 footnotes to the Definitions section.*
2. *Tables 5.5-1 through 5.5-8, the tables of prescriptive criteria for the building envelope have been updated. For opaque elements, minimum insulation levels have increased for most assemblies in most climates. For vertical fenestration, the new criteria call for double-glazing with low-e in most climates, with triple-glazing in Alaska (so as to reduce energy consumption for space heating, which most often occurs during morning warm-up when lights and equipment are off and before the sun has risen), and good solar control (so as to reduce energy consumption for space cooling, which occurs primarily during daytime occupied hours). Also, a minimum VT/SHGC ratio has been added to enable good daylighting with minimum solar gain, while not restricting triple- and quadruple-glazing. The skylight criteria has been simplified for greater consistency with the* 2009 International Energy Conservation Code *(IECC). Also, see the text below for new footnotes added for fenestration U-factor criteria in Climate Zone 1 areas other than Miami and Hawaii and for floor insulation criteria in cold climates.*
3. *Section 5.5.3.1, the high albedo roof alternative was updated to reflect new roof insulation values in Table 5-5.*
4. *Section 5.5.3.2, the location of the applicable text of the Table 5.5 footnote for the insulation in masonry cores (sometimes called* the perlite exception*) was moved from Appendix A (Section A3.1.3.1) to Section 5. This is where it was located in the 1999 and 2001 editions of the standard. The language is the same, except it starts with the word "alternatively" as it did in the 1999 and 2001 editions of the standard, and the footnote reference has been updated to "b". This clarifies the language.*
5. *Section 5.5.3.4, a steel-joist floor and wood-framed floor exception was added to account for increased insulation levels that occur in floors (similar to the single-rafter roof exception).*
6. *Section 5.5.4.2, the area references were deleted as they are already specified in Table 5.5, and an exception was added to allow the skylight area to be increased to 6% where skylights are designed and utilized as part of a daylighting scheme.*
7. *Section 5.5.4.3, one exception was added to allow the skylight U-factor to be increased where skylights are designed and utilized as part of a daylighting scheme. Also, more stringent U-factors are specified for vertical fenestration in areas of Climate Zone 1 with higher cooling design temperatures (e.g., Saudi Arabia).*
8. *Section 5.5.4.4, an exception was added to allow a modification of the SHGC criteria for vertical fenestration that faces north to account for the reduced solar heat gain on the north side of buildings in cold climates.*
9. *Section 5.5.4.5, text was added to refer to the table criteria for VT/SHGC.*
10. *Appendix A2.3, metal building roofs has been updated.*
11. *Appendix A3.1, mass walls has been updated to add new assemblies and eliminate ones that are no longer used.*
12. *Appendix A3.2, metal building walls has been updated.*
13. *Appendix A9, has been modified to include a calculation procedure for metal building roof insulation where the insulation is compressed.*

Note: *In this addendum, changes to the current standard are indicated in the text by* underlining *(for additions) and* ~~strikethrough~~ *(for deletions) unless the instructions specifically mention some other means of indicating the changes.*

Addendum bb to Standard 90.1-2010

Revise the Standard as follows (I-P and SI units).

Modify Section 3.2, Definitions, as follows.

…

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

…

entrance door: see *fenestration*.

…

fenestration: all areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, doors that are more than one-half glass, and glass block walls. (See *building envelope* and *door.*)

fixed: see *fenestration.*

…

light-to-solar gain ratio (LSG): the ratio of the center-of-glass visible transmittance to the center-of-glass solar heat gain coefficient.

…

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

…

north-oriented: facing within 45 degrees of true north ~~(~~in the northern hemisphere (however, facing within 45 degrees of true south in the southern hemisphere).

…

operable: see *fenestration*.

…

vertical fenestration: all fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 12 in. (300 mm) of a mass wall, are considered walls, not fenestration. For the purposes of determining building envelope requirements, the vertical fenestration classifications are defined as follows:

> ***metal framing:*** products with metal framing with or without thermal break.
>
> ***metal framing, entrance door:*** any doorway, set of doors, turnstile, vestibule, or other form of portal that is ordinarily used to gain access by its users and occupants to the building or to individual tenant spaces accessed from the exterior. (See also *building entrance* door.)
>
> ***metal framing, fixed:*** all *vertical fenestration*, other than *entrance door* and *operable*, including, but not limited to, curtain walls, window walls, fixed windows, picture windows, glass block walls, non-openable clerestory windows, and non-openable sidelites and transoms.
>
> ***metal framing, operable:*** all *vertical fenestration* that opens, except *entrance doors*, including, but not limited to, casement windows, projecting windows, pivoting windows, horizontal sliding windows, vertical sliding windows, openable clerestory windows, openable sidelites and transoms, sliding glass doors, and doors that are not *entrance doors*.
>
> ***nonmetal framing:*** all products with framing materials other than metal with or without metal reinforcing or cladding.

Add the following to Section 3.3, Abbreviations and Acronyms.

VT	visible transmittance (also known as *VLT, visible light transmittance*)
FC	filled cavity
LSG	light-to-solar-gain ratio

Delete Tables 5.5-1 through 5.5-8 in their entirety and replace with the following (underlines removed for clarity):

I-P units:

TABLE 5.5-1 Building Envelope Requirements For Climate Zone 1 (A,B,C) (I-P)*

OPAQUE ELEMENTS	NONRESIDENTIAL Assembly Maximum	NONRESIDENTIAL Insulation Min. R –Value	RESIDENTIAL Assembly Maximum	RESIDENTIAL Insulation Min. R-Value	SEMIHEATED Assembly Maximum	SEMIHEATED Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U- 0.048	R-20 c.i.	U- 0.039	R-25 c.i.	U- 0.218	R-3.8 c.i.
Metal Building[a]	U- 0.041	R-10 + R-19 FC	U- 0.041	R-10 + R-19 FC	U- 0.115	R-10
Attic and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.081	R-13
Walls, Above Grade						
Mass	U- 0.580	NR	U- 0.151[b]	R-5.7 c.i.[b]	U- 0.580	NR
Metal Building	U- 0.094	R-0 + R-9.8 c.i.	U- 0.094	R-0 + R-9.8 c.i.	U- 0.352	NR
Steel Framed	U- 0.124	R-13	U- 0.124	R-13	U- 0.352	NR
Wood Framed and Other	U- 0.089	R-13	U- 0.089	R-13	U- 0.292	NR
Wall, Below Grade						
Below Grade Wall	C- 1.140	NR	C- 1.140	NR	C- 1.140	NR
Floors						
Mass	U- 0.322	NR	U- 0.322	NR	U- 0.322	NR
Steel Joist	U- 0.350	NR	U- 0.350	NR	U- 0.350	NR
Wood Framed and Other	U- 0.282	NR	U- 0.282	NR	U- 0.282	NR
Slab-On-Grade Floors						
Unheated	F- 0.730	NR	F- 0.730	NR	F- 0.730	NR
Heated	F- 1.020	R-7.5 for 12 in.	F- 1.020	R-7.5 for 12 in.	F- 1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U- 0.700		U- 0.500		U- 0.700	
Non-Swinging	U- 1.450		U- 0.500		U- 1.450	

FENESTRATION	NONRESIDENTIAL Assembly Max. U	NONRESIDENTIAL Assembly Max. SHGC	NONRESIDENTIAL Assembly Min. VT/SHGC	RESIDENTIAL Assembly Max. U	RESIDENTIAL Assembly Max. SHGC	RESIDENTIAL Assembly Min. VT/SHGC	SEMIHEATED Assembly Max. U	SEMIHEATED Assembly Max. SHGC	SEMIHEATED Assembly Min. VT/SHGC
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.50[c]	SHGC-0.25	1.10	U- 0.50[c]	SHGC-0.25	1.10	U- 0.93	NR	NR
Metal framing, fixed	U- 0.57[c]			U- 0.57[c]			U- 1.20		
Metal framing, operable	U- 0.65[c]			U- 0.65[c]			U- 1.20		
Metal framing, entrance door	U- 1.10[c]			U- 1.10[c]			U- 1.10[c]		
Skylight, 0-3% of Roof									
All types	U- 0.75	SHGC-0.35	NR	U- 0.75	SHGC-0.35	NR	U- 1.80	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.
[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).
[b] Exception to Section 5.5.3.2 applies for mass walls above grade.
[c] For locations in Climate Zone 1 with a *cooling design temperature* of 95 °F (35 C) and greater, see Section 5.5.4.3 for the maximum U-factors for vertical fenestration.

TABLE 5.5-2 Building Envelope Requirements For Climate Zone 2 (A,B) (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.039	R-25 c.i.	U- 0.039	R-25 c.i.	U- 0.173	R-5 c.i.
Metal Building[a]	U- 0.041	R-10 + R-19 FC	U- 0.041	R-10 + R-19 FC	U- 0.096	R-16
Attic and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.053	R-19
Walls, Above Grade						
Mass	U- 0.151[b]	R-5.7 c.i.[b]	U- 0.123	R-7.6 c.i.	U- 0.580	NR
Metal Building	U- 0.094	R-0 + R-9.8 c.i.	U- 0.094	R-0 + R-9.8. c.i.	U- 0.162	R-13
Steel Framed	U- 0.084	R-13 + R-3.8 c.i.	U- 0.064	R-13 + R-7.5 c.i.	U- 0.124	R-13
Wood Framed and Other	U- 0.089	R-13	U- 0.089	R-13	U- 0.089	R-13
Wall, Below Grade						
Below Grade Wall	C- 1.140	NR	C- 1.140	NR	C- 1.140	NR
Floors						
Mass	U- 0.107	R-6.3 c.i.	U- 0.087	R-8.3 c.i.	U- 0.322	NR
Steel Joist	U- 0.038	R-30	U- 0.038	R-30	U- 0.069	R-13
Wood Framed and Other	U- 0.033	R-30	U- 0.033	R-30	U- 0.066	R-13
Slab-On-Grade Floors						
Unheated	F- 0.730	NR	F- 0.730	NR	F- 0.730	NR
Heated	F- 0.900	R-10 for 24 in.	F- 0.860	R-15 for 24 in.	F- 1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U- 0.700		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 1.450	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.40	SHGC-0.25	1.10	U- 0.40	SHGC-0.25	1.10	U- 0.93	NR	NR
Metal framing, fixed	U- 0.57			U- 0.57			U- 1.20		
Metal framing, operable	U- 0.65			U- 0.65			U- 1.20		
Metal framing, entrance door	U- 0.83			U- 0.77			U- 0.83		
Skylight, 0-3% of Roof									
All types	U- 0.65	SHGC-0.35	NR	U- 0.65	SHGC-0.35	NR	U- 1.80	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A,B,C) (I-P)*

OPAQUE ELEMENTS	NONRESIDENTIAL Assembly Maximum	NONRESIDENTIAL Insulation Min. R –Value	RESIDENTIAL Assembly Maximum	RESIDENTIAL Insulation Min. R –Value	SEMIHEATED Assembly Maximum	SEMIHEATED Insulation Min. R –Value
Roofs						
Insulation Entirely above Deck	U- 0.039	R-25 c.i.	U- 0.039	R-25 c.i.	U- 0.119	R-7.6 c.i.
Metal Building[a]	U- 0.041	R-10 + R-19 FC	U- 0.041	R-10 + R-19 FC	U- 0.096	R-16
Attic and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.053	R-19
Walls, Above Grade						
Mass	U- 0.123	R-7.6 c.i.	U- 0.104	R-9.5 c.i.	U- 0.580	NR
Metal Building	U- 0.094	R-0 + R-9.8 c.i.	U- 0.072	R-0 + R-13 c.i.	U- 0.162	R-13
Steel Framed	U- 0.077	R-13 + R-5 c.i.	U- 0.064	R-13 + R-7.5 c.i.	U- 0.124	R-13
Wood Framed and Other	U- 0.089	R-13	U- 0.064	R-13 + R-3.8 c.i. or R-20	U- 0.089	R-13
Wall, Below Grade						
Below Grade Wall	C- 1.140	NR	C- 1.140	NR	C- 1.140	NR
Floors						
Mass	U- 0.074	R-10 c.i.	U- 0.074	R-10 c.i.	U- 0.137	R-4.2 c.i.
Steel Joist	U- 0.052	R-19	U- 0.032	R-38	U- 0.052	R-19
Wood Framed and Other	U- 0.033	R-30	U- 0.033	R-30	U- 0.051	R-19
Slab-On-Grade Floors						
Unheated	F- 0.730	NR	F- 0.540	R-10 for 24 in.	F- 0.730	NR
Heated	F- 0.860	R-15 for 24 in.	F- 0.860	R-15 for 24 in.	F- 1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U- 0.700		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 1.450	

FENESTRATION	NONRESIDENTIAL Assembly Max. U	NONRESIDENTIAL Assembly Max. SHGC	NONRESIDENTIAL Assembly Min. VT/SHGC	RESIDENTIAL Assembly Max. U	RESIDENTIAL Assembly Max. SHGC	RESIDENTIAL Assembly Min. VT/SHGC	SEMIHEATED Assembly Max. U	SEMIHEATED Assembly Max. SHGC	SEMIHEATED Assembly Min. VT/SHGC
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.35			U- 0.35			U- 0.87		
Metal framing, fixed	U- 0.50	SHGC-0.25	1.10	U- 0.50	SHGC-0.25	1.10	U- 1.20	NR	NR
Metal framing, operable	U- 0.60			U- 0.60			U- 1.20		
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.55	SHGC-0.35	NR	U- 0.55	SHGC-0.35	NR	U- 1.70	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-4 Building Envelope Requirements For Climate Zone 4 (A,B,C) (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.032	R-30 c.i.	U- 0.032	R-30 c.i.	U- 0.093	R-10 c.i.
Metal Building[a]	U- 0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U- 0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U- 0.082	R-19
Attic and Other	U- 0.021	R-49	U- 0.021	R-49	U- 0.034	R-30
Walls, Above Grade						
Mass	U- 0.104	R-9.5 c.i.	U- 0.090	R-11.4 c.i.	U- 0.580	NR
Metal Building	U- 0.060	R-0 + R-15.8 c.i.	U- 0.050	R-0 + R-19 c.i.	U- 0.162	R-13
Steel Framed	U- 0.064	R-13 + R-7.5 c.i.	U- 0.064	R-13 + R-7.5 c.i	U- 0.124	R-13
Wood Framed and Other	U- 0.064	R-13 + R-3.8 c.i. or R-20	U- 0.064	R-13 + R-3.8 c.i. or R-20	U- 0.089	R-13
Wall, Below Grade						
Below Grade Wall	C- 0.119	R-7.5 c.i.	C- 0.092	R-10 c.i.	C- 1.140	NR
Floors						
Mass	U- 0.057	R-14.6 c.i.	U- 0.051	R-16.7 c.i.	U- 0.107	R-6.3 c.i.
Steel Joist	U- 0.038	R-30	U- 0.038	R-30	U- 0.052	R-19
Wood Framed and Other	U- 0.033	R-30	U- 0.033	R-30	U- 0.051	R-19
Slab-On-Grade Floors						
Unheated	F- 0.520	R-15 for 24 in.	F- 0.520	R-15 for 24 in.	F- 0.730	NR
Heated	F- 0.843	R-20 for 24 in.	F- 0.688	R-20 for 48 in.	F- 0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U- 0.500		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 1.450	

	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.35			U- 0.35			U- 0.51		
Metal framing, fixed	U- 0.42			U- 0.42			U- 0.73		
Metal framing, operable	U- 0.50	SHGC-0.40	1.10	U- 0.50	SHGC-0.40	1.10	U- 0.81	NR	NR
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.50	SHGC-0.40	NR	U- 0.50	SHGC-0.40	NR	U- 1.15	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-5 Building Envelope Requirements For Climate Zone 5 (A,B,C) (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R –Value**
Roofs						
Insulation Entirely above Deck	U- 0.032	R-30 c.i.	U- 0.032	R-30 c.i.	U- 0.063	R-15 c.i.
Metal Building[a]	U- 0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U- 0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U- 0.082	R-19
Attic and Other	U- 0.021	R-49	U- 0.021	R-49	U- 0.034	R-30
Walls, Above Grade						
Mass	U- 0.090	R-11.4 c.i.	U- 0.080	R-13.3 c.i.	U- 0.151[b]	R-5.7 c.i.[b]
Metal Building	U- 0.050	R-0 + R-19 c.i.	U- 0.050	R-0 + R-19 c.i.	U- 0.094	R-0 + R-9.8 c.i.
Steel Framed	U- 0.055	R-13 + R-10 c.i.	U- 0.055	R-13 + R-10 c.i.	U- 0.084	R-13+R-3.8 c.i.
Wood Framed and Other	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.089	R-13
Wall, Below Grade						
Below Grade Wall	C- 0.119	R-7.5 c.i.	C- 0.092	R-10 c.i.	C- 1.140	NR
Floors						
Mass	U- 0.057	R-14.6 c.i.	U- 0.051	R-16.7 c.i.	U- 0.107	R-6.3 c.i.
Steel Joist	U- 0.038	R-30	U- 0.038	R-30	U- 0.052	R-19
Wood Framed and Other	U- 0.033	R-30	U- 0.033	R-30	U- 0.051	R-19
Slab-On-Grade Floors						
Unheated	F- 0.520	R-15 for 24 in	F- 0.510	R-20 for 24 in.	F- 0.730	NR
Heated	F- 0.688	R-20 for 48 in.	F- 0.688	R-20 for 48 in.	F- 0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U- 0.500		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 1.450	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.32	SHGC- 0.40	1.10	U- 0.32	SHGC- 0.40	1.10	U- 0.45	NR	NR
Metal framing, fixed	U- 0.42			U- 0.42			U- 0.62		
Metal framing, operable	U- 0.50			U- 0.50			U- 0.70		
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.50	SHGC- 0.40	NR	U- 0.50	SHGC- 0.40	NR	U- 0.98	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-6 Building Envelope Requirements For Climate Zone 6 (A,B) (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R –Value**
Roofs						
Insulation Entirely above Deck	U- 0.032	R-30 c.i.	U- 0.032	R-30 c.i.	U- 0.063	R-15 c.i.
Metal Building[a]	U- 0.031	R-25 + R-11 Ls	U- 0.029	R-30 + R-11 Ls	U- 0.060	R-19 + R-19
Attic and Other	U- 0.021	R-49	U- 0.021	R-49	U- 0.034	R-30
Walls, Above Grade						
Mass	U- 0.080	R-13.3 c.i.	U- 0.071	R-15.2 c.i.	U- 0.151[b]	R-5.7 c.i.[b]
Metal Building	U- 0.050	R-0 + R-19 c.i.	U- 0.050	R-0 + R-19 c.i.	U- 0.094	R-0 + R-9.8 c.i.
Steel Framed	U- 0.049	R-13 + R-12.5 c.i.	U- 0.049	R-13 + R-12.5 c.i.	U- 0.084	R-13 + R-3.8 c.i.
Wood Framed and Other	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.089	R-13
Wall, Below Grade						
Below Grade Wall	C- 0.092	R-10 c.i.	C- 0.063	R-15 c.i.	C- 0.119	R-7.5 c.i
Floors						
Mass	U- 0.051	R-16.7 c.i.	U- 0.051	R-16.7 c.i.	U- 0.087	R-8.3 c.i.
Steel Joist	U- 0.032	R-38	U- 0.032	R-38	U- 0.052	R-19
Wood Framed and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.051	R-19
Slab-On-Grade Floors						
Unheated	F- 0.510	R-20 for 24 in.	F- 0.434	R-20 for 48 in	F- 0.730	NR
Heated	F- 0.688	R-20 for 48 in.	F- 0.671	R-25 for 48 in.	F- 0.860	R-15 for 24 in.
Opaque Doors						
Swinging	U- 0.500		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 0.500	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.32	SHGC-0.40	1.10	U- 0.32	SHGC-0.40	1.10	U- 0.45	NR	NR
Metal framing, fixed	U- 0.42			U- 0.42			U- 0.51		
Metal framing, operable	U- 0.50			U- 0.50			U- 0.59		
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.50	SHGC-0.40	NR	U- 0.50	SHGC-0.40	NR	U- 0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-7 Building Envelope Requirements For Climate Zone 7 (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.028	R-35 c.i.	U- 0.028	R-35 c.i.	U- 0.039	R-25 c.i.
Metal Building[a]	U- 0.029	R-30 + R-11 Ls	U- 0.029	R-30 + R-11 Ls	U- 0.037	R-19 + R-11 Ls or R-25 + R-8 Ls
Attic and Other	U- 0.017	R-60	U- 0.017	R-60	U- 0.027	R-38
Walls, Above Grade						
Mass	U- 0.071	R-15.2 c.i.	U- 0.071	R-15.2 c.i.	U- 0.123	R-7.6 c.i.
Metal Building	U- 0.044	R-0 + R.22.1 c.i.	U- 0.044	R-0 + R.22.1 c.i.	U- 0.072	R-0 + R-13 c.i.
Steel Framed	U- 0.049	R-13 + R-12.5 c.i.	U- 0.042	R-13 + R-15.6 c.i.	U- 0.064	R-13 + R-7.5 c.i.
Wood Framed and Other	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U- 0.064	R-13 + R-3.8 c.i,
Wall, Below Grade						
Below Grade Wall	C- 0.063	R-15 c.i.	C- 0.063	R-15 c.i.	C- 0.119	R-7.5 c.i.
Floors						
Mass	U- 0.042	R-20.9 c.i.	U- 0.042	R-20.9 c.i.	U- 0.074	R-10.4 c.i.
Steel Joist	U- 0.032	R-38	U- 0.032	R-38	U- 0.052	R-19
Wood Framed and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.051	R-19
Slab-On-Grade Floors						
Unheated	F- 0.510	R-20 for 24 in.	F- 0.434	R-20 for 48 in.	F- 0.730	NR
Heated	F- 0.671	R-25 for 48 in.	F- 0.671	R-25 for 48 in.	F- 0.860	R-15 for 24 in.
Opaque Doors						
Swinging	U- 0.500		U- 0.500		U- 0.700	
Non-Swinging	U- 0.500		U- 0.500		U- 0.500	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.32	SHGC-0.45	1.10	U- 0.32	SHGC-0.45	1.10	U- 0.32	NR	NR
Metal framing, fixed	U- 0.38			U- 0.38			U- 0.38		
Metal framing, operable	U- 0.40			U- 0.40			U- 0.44		
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.50	NR	NR	U- 0.50	NR	NR	U- 0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-8 Building Envelope Requirements For Climate Zone 8 (I-P)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.028	R-35 c.i.	U- 0.028	R-35 c.i.	U- 0.039	R-25 c.i.
Metal Building[a]	U- 0.026	R-25 + R-11+R-11 Ls	U- 0.026	R-25 + R-11+R-11 Ls	U- 0.037	R-19+R-11 Ls or R-25 + R-8 Ls
Attic and Other	U- 0.017	R-60	U- 0.017	R-60	U- 0.027	R-38
Walls, Above Grade						
Mass	U- 0.048	R-19 c.i.	U- 0.048	R-19 c.i.	U- 0.104	R-9.5 c.i.
Metal Building	U- 0.039	R-0 + R-25 c.i.	U- 0.039	R-0 + R-25 c.i.	U- 0.060	R-0 + R-15.8 c.i.
Steel Framed	U- 0.037	R-13 + R-18.8 c.i.	U- 0.037	R-13 + R-18.8 c.i.	U- 0.064	R-13 + R-7.5 c.i.
Wood Framed and Other	U- 0.032	R-13 + R-18.8 c.i.	U- 0.032	R-13 + R-18.8 c.i.	U- 0.051	R-13 + R-7.5 c.i.
Wall, Below Grade						
Below Grade Wall	C- 0.063	R-15 c.i.	C- 0.063	R-15 c.i.	C- 0.119	R-7.5 c.i.
Floors						
Mass	U- 0.038	R-23 c.i.	U- 0.038	R-23 c.i.	U- 0.064	R-12.5 c.i.
Steel Joist	U- 0.032	R-38	U- 0.032	R-38	U- 0.052	R-19
Wood Framed and Other	U- 0.027	R-38	U- 0.027	R-38	U- 0.033	R-30
Slab-On-Grade Floors						
Unheated	F- 0.434	R-20 for 48 in.	F- 0.424	R-25 for 48 in.	F- 0.540	R-10 for 24 in.
Heated	F- 0.671	R-25 for 48 in.	F- 0.373	R-20 full slab	F- 0.860	R-15 for 24 in.
Opaque Doors						
Swinging	U- 0.500		U- 0.500		U- 0.500	
Non-Swinging	U- 0.500		U- 0.500		U- 0.500	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 0.32	SHGC-0.45	1.10	U- 0.32	SHGC-0.45	1.10	U- 0.32	NR	NR
Metal framing, fixed	U- 0.38			U- 0.38			U- 0.38		
Metal framing, operable	U- 0.40			U- 0.40			U- 0.44		
Metal framing, entrance door	U- 0.77			U- 0.68			U- 0.77		
Skylight, 0-3% of Roof									
All types	U- 0.50	NR	NR	U- 0.50	NR	NR	U- 0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

SI units:

TABLE 5.5-1 Building Envelope Requirements For Climate Zone 1 (A,B,C) (SI)*

	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R –Value**		**Assembly Maximum**	**Insulation Min. R –Value**		**Assembly Maximum**	**Insulation Min. R -Value**	
Roofs									
Insulation Entirely above Deck	U- 0.273	R-3.5 c.i.		U- 0.220	R-4.4 c.i.		U- 1.240	R-0.7 c.i.	
Metal Building[a]	U- 0.233	R-1.8 + R-3.3 FC		U- 0.233	R-1.8 + R-3.3 FC		U- 0.653	R-1.8	
Attic and Other	U- 0.153	R-6.7		U- 0.153	R-6.7		U- 0.459	R-2.3	
Walls, Above Grade									
Mass	U- 3.293	NR		U- 0.857[b]	R-1.0 c.i.[b]		U- 3.293	NR	
Metal Building	U- 0.533	R-0 + R-1.7 c.i.		U- 0.533	R-0 + R-1.7 c.i.		U- 1.998	NR	
Steel Framed	U- 0.705	R-2.3		U- 0.705	R-2.3		U- 1.998	NR	
Wood Framed and Other	U- 0.504	R-2.3		U- 0.504	R-2.3		U- 1.660	NR	
Wall, Below Grade									
Below Grade Wall	C- 6.473	NR		C- 6.473	NR		C- 6.473	NR	
Floors									
Mass	U- 1.825	NR		U- 1.825	NR		U- 1.825	NR	
Steel Joist	U- 1.986	NR		U- 1.986	NR		U- 1.986	NR	
Wood Framed and Other	U- 1.599	NR		U- 1.599	NR		U- 1.599	NR	
Slab-On-Grade Floors									
Unheated	F- 1.264	NR		F- 1.264	NR		F- 1.264	NR	
Heated	F- 1.766	R-1.3 for 300 mm		F- 1.766	R-1.3 for 300 mm		F- 1.766	R-1.3 for 300 mm	
Opaque Doors									
Swinging	U- 3.975			U- 2.839			U- 3.975		
Non-Swinging	U- 8.233			U- 2.839			U- 8.233		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 2.84[c]	SHGC-0.25	1.10	U- 2.84[c]	SHGC-0.25	1.10	U- 5.28	NR	NR
Metal framing, fixed	U- 3.24[c]			U- 3.24[c]			U- 6.81		
Metal framing, operable	U- 3.69[c]			U- 3.69[c]			U- 6.81		
Metal framing, entrance door	U- 6.25[c]			U- 6.25[c]			U- 6.25[c]		
Skylight, 0-3% of Roof									
All types	U- 4.26	SHGC-0.35	NR	U- 4.26	SHGC-0.35	NR	U- 10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.
[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).
[b] Exception to Section 5.5.3.2 applies for mass walls above grade.
[c] For locations in Climate Zone 1 with a *cooling design temperature* of 35 C and greater, see Section 5.5.4.3 for the maximum U-factors for vertical fenestration.

TABLE 5.5-2 Building Envelope Requirements For Climate Zone 2 (A,B) (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.220	R-4.4 c.i.	U- 0.220	R-4.4 c.i.	U- 0.982	R-0.9 c.i.
Metal Building[a]	U- 0.233	R-1.8 + R-3.3 FC	U- 0.233	R-1.8 + R-3.3 FC	U- 0.545	R-2.8
Attic and Other	U- 0.153	R-6.7	U- 0.153	R-6.7	U- 0.300	R-3.3
Walls, Above Grade						
Mass	U- 0.857[b]	R-1.0 c.i.[b]	U- 0.701	R-1.3 c.i.	U- 3.293	NR
Metal Building	U- 0.533	R-0 + R-1.7 c.i.	U- 0.533	R-0 + R-1.7 c.i.	U- 0.920	R-2.3
Steel Framed	U- 0.479	R-2.3 + R-0.7 c.i.	U- 0.365	R-2.3 + R-1.3 c.i.	U- 0.705	R-2.3
Wood Framed and Other	U- 0.504	R-2.3	U- 0.504	R-2.3	U- 0.504	R-2.3
Wall, Below Grade						
Below Grade Wall	C- 6.473	NR	C- 6.473	NR	C- 6.473	NR
Floors						
Mass	U- 0.606	R-1.9	U- 0.496	R-1.5	U- 1.825	NR
Steel Joist	U- 0.214	R-5.3	U- 0.214	R-5.3	U- 0.390	R-2.3
Wood Framed and Other	U- 0.188	R-5.3	U- 0.188	R-5.3	U- 0.376	R-2.3
Slab-On-Grade Floors						
Unheated	F- 1.264	NR	F- 1.264	NR	F- 1.264	NR
Heated	F- 1.558	R-1.8 for 600 mm	F- 1.489	R-2.6 for 600 mm	F- 1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U- 3.975		U- 2.839		U- 3.975	
Non-Swinging	U- 2.839		U- 2.839		U- 8.233	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 2.27			U- 2.27			U- 5.28		
Metal framing, fixed	U- 3.24			U- 3.24			U- 6.81		
Metal framing, operable	U- 3.69	SHGC-0.25	1.10	U- 3.69	SHGC-0.25	1.10	U- 6.81	NR	NR
Metal framing, entrance door	U- 4.71			U- 4.37			U- 4.71		
Skylight, 0-3% of Roof									
All types	U- 3.69	SHGC-0.35	NR	U- 3.69	SHGC-0.35	NR	U- 10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A,B,C) (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R –Value**	**Assembly Maximum**	**Insulation Min. R –Value**
Roofs						
Insulation Entirely above Deck	U- 0.220	R-4.4 c.i.	U- 0.220	R-4.4 c.i.	U- 0.677	R-1.3 c.i.
Metal Building[a]	U- 0.233	R-1.8 + R-3.3 FC	U- 0.233	R-1.8 + R-3.3 FC	U- 0.545	R-2.8
Attic and Other	U- 0.153	R-6.7	U- 0.153	R-6.7	U- 0.300	R-3.3
Walls, Above Grade						
Mass	U- 0.701	R-1.3 c.i.	U- 0.592	R-1.7 c.i.	U- 3.293	NR
Metal Building	U- 0.533	R-0 + R-1.7 c.i.	U- 0.410	R-0 + R-2.3 c.i.	U- 0.920	R-2.3
Steel Framed	U- 0.435	R-2.3 + R-0.9 c.i.	U- 0.365	R-2.3 + R-1.3 c.i.	U- 0.705	R-2.3
Wood Framed and Other	U- 0.504	R-2.3	U- 0.365	R-2.3 + R-0.7 c.i. or R-3.5	U- 0.504	R-2.3
Wall, Below Grade						
Below Grade Wall	C- 6.473	NR	C- 6.473	NR	C- 6.473	NR
Floors						
Mass	U- 0.420	R-1.8 c.i.	U- 0.420	R-1.8 c.i.	U- 0.780	R-0.7 c.i.
Steel Joist	U- 0.296	R-3.3	U- 0.183	R-6.7	U- 0.296	R-3.3
Wood Framed and Other	U- 0.188	R-5.3	U- 0.188	R-5.3	U- 0.288	R-3.3
Slab-On-Grade Floors						
Unheated	F- 1.264	NR	F- 0.935	R-1.8 for 600 mm	F- 1.264	NR
Heated	F- 1.489	R-2.6 for 600 mm	F- 1.489	R-2.6 for 600 mm	F- 1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U- 3.975		U- 2.839		U- 3.975	
Non-Swinging	U- 2.839		U- 2.839		U- 8.233	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.99			U- 1.99			U- 4.94		
Metal framing, fixed	U- 2.84	SHGC-0.25	1.10	U- 2.84	SHGC-0.25	1.10	U- 6.81	NR	NR
Metal framing, operable	U- 3.41			U- 3.41			U- 6.81		
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 3.12	SHGC-0.35	NR	U- 3.12	SHGC-0.35	NR	U- 9.65	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-4 Building Envelope Requirements For Climate Zone 4 (A,B,C) (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.184	R-5.3 c.i.	U- 0.184	R-5.3 c.i.	U- 0.527	R-1.8 c.i.
Metal Building[a]	U- 0.210	R-3.3 + R-1.9 Ls or R-4.4 + R-1.4 Ls	U- 0.210	R-3.3 + R-1.9 Ls or R-4.4 + R-1.4	U- 0.466	R-3.3
Attic and Other	U- 0.119	R-8.6	U- 0.119	R-8.6	U- 0.192	R-5.3
Walls, Above Grade						
Mass	U- 0.592	R-1.7 c.i.	U- 0.513	R-2.0 c.i.	U- 3.293	NR
Metal Building	U- 0.341	R-0 + R-2.8 c.i.	U- 0.286	R-0 + R-3.3 c.i.	U- 0.920	R-2.3
Steel Framed	U- 0.365	R-2.3 + R-1.3 c.i.	U- 0.365	R-2.3 + R-1.3 c.i.	U- 0.705	R-2.3
Wood Framed and Other	U- 0.365	R-2.3 + R-0.7 c.i. or R-3.5	U- 0.365	R-2.3 + R-0.7 c.i. or R-3.5	U- 0.504	R-2.3
Wall, Below Grade						
Below Grade Wall	C- 0.678	R-1.3 c.i.	C- 0.522	R-1.8 c.i.	C- 6.473	NR
Floors						
Mass	U- 0.321	R-2.6 c.i.	U- 0.287	R-2.9 c.i.	U- 0.606	R-1.1 c.i.
Steel Joist	U- 0.214	R-5.3	U- 0.214	R-5.3	U- 0.296	R-3.3
Wood Framed and Other	U- 0.188	R-5.3	U- 0.188	R-5.3	U- 0.288	R-3.3
Slab-On-Grade Floors						
Unheated	F- 0.900	R-2.6 for 600 mm	F- 0.900	R-2.6 for 600 mm	F- 1.264	NR
Heated	F- 1.459	R-3.5 for 600 mm	F- 1.191	R-3.5 for 1200 mm	F- 1.558	R-1.8 for 600 mm
Opaque Doors						
Swinging	U- 2.839		U- 2.839		U- 3.975	
Non-Swinging	U- 2.839		U- 2.839		U- 8.233	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.99	SHGC-0.40	1.10	U- 1.99	SHGC-0.40	1.10	U- 2.90	NR	NR
Metal framing, fixed	U- 2.38			U- 2.38			U- 4.14		
Metal framing, operable	U- 2.84			U- 2.84			U- 4.60		
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 2.84	SHGC-0.40	NR	U- 2.84	SHGC-0.40	NR	U- 6.53	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-5 Building Envelope Requirements For Climate Zone 5 (A,B,C) (SI)*

	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R –Value**		**Assembly Maximum**	**Insulation Min. R –Value**		**Assembly Maximum**	**Insulation Min. R –Value**	
Roofs									
Insulation Entirely above Deck	U- 0.184	R-5.3 c.i.		U- 0.184	R-5.3 c.i.		U- 0.360	R-2.6 c.i.	
Metal Building[a]	U- 0.210	R-3.3 + R-1.9 Ls or R-4.4 + R1.4 Ls		U- 0.210	R-3.3 + R-1.9 Ls or R-4.4 + R1.4 Ls		U- 0.466	R-3.3	
Attic and Other	U- 0.119	R-8.6		U- 0.119	R-8.6		U- 0.192	R-5.3	
Walls, Above Grade									
Mass	U- 0.513	R-2.0 c.i.		U- 0.453	R-2.3 c.i.		U- 0.857[b]	R-1.0 c.i.[b]	
Metal Building	U- 0.286	R-0 + R-3.3 c.i.		U- 0.286	R-0 + R-3.3 c.i.		U- 0.533	R-0 + R-1.7 c.i.	
Steel Framed	U- 0.315	R-2.3 + R-1.8 c.i.		U- 0.315	R-2.3 + R-1.8 c.i.		U- 0.479	R-2.3+ R-0.7 c.i.	
Wood Framed and Other	U- 0.291	R-2.3 + R-0.9 c.i. or R-3.3 + R-0.9 c.i.		U- 0.291	R-2.3 + R-0.9 c.i. or R-3.3 + R-0.9 c.i.		U- 0.504	R-2.3	
Wall, Below Grade									
Below Grade Wall	C- 0.678	R-1.3 c.i.		C- 0.522	R-1.8 c.i.		C- 6.473	NR	
Floors									
Mass	U- 0.321	R-2.6 c.i.		U- 0.287	R-2.9 c.i.		U- 0.606	R-1.1 c.i.	
Steel Joist	U- 0.214	R-5.3		U- 0.214	R-5.3		U- 0.296	R-3.3	
Wood Framed and Other	U- 0.188	R-6.7		U- 0.188	R-6.7		U- 0.288	R-3.3	
Slab-On-Grade Floors									
Unheated	F- 0.900	R-2.6 for 600 in		F- 0.882	R-3.5 for 600 mm		F- 1.264	NR	
Heated	F- 1.191	R-3.5 for 1200 mm		F- 1.191	R-3.5 for 1200 mm		F- 1.558	R-1.8 for 600 mm	
Opaque Doors									
Swinging	U- 2.839			U- 2.839			U- 3.975		
Non-Swinging	U- 2.839			U- 2.839			U- 8.233		
FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.82			U- 1.82			U- 2.56		
Metal framing, fixed	U- 2.38			U- 2.38			U- 3.52		
Metal framing, operable	U- 2.84	SHGC-0.40	1.10	U- 2.84	SHGC-0.40	1.10	U- 3.97	NR	NR
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 2.84	SHGC-0.40	NR	U- 2.84	SHGC-0.40	NR	U- 5.56	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-6 Building Envelope Requirements For Climate Zone 6 (A,B) (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R –Value**
Roofs						
Insulation Entirely above Deck	U- 0.184	R-5.3 c.i.	U- 0.184	R-5.3 c.i.	U- 0.360	R-2.6 c.i.
Metal Building[a]	U- 0.175	R-4.4 + R-1.9 Ls	U- 0.163	R-5.3 + R-1.9 Ls	U- 0.341	R-3.3 + R-3.3
Attic and Other	U- 0.119	R-8.6	U- 0.119	R-8.6	U- 0.192	R-5.3
Walls, Above Grade						
Mass	U- 0.453	R-2.3 c.i.	U- 0.404	R-2.7 c.i.	U- 0.857[b]	R-1.0 c.i.[b]
Metal Building	U- 0.286	R-0 + R-3.3 c.i.	U- 0.286	R-0 + R-3.3 c.i.	U- 0.533	R-0 + R-1.7 c.i.
Steel Framed	U- 0.277	R-2.3 + R-2.2 c.i.	U- 0.277	R-2.3 + R-2.2 c.i.	U- 0.479	R-2.3 + R-0.7 c.i.
Wood Framed and Other	U- 0.291	R-2.3 + R-1.3 c.i. or R-3.3 + R-0.9 c.i.	U- 0.291	R-2.3 + R-1.3 c.i. or R-3.3 + R-0.9 c.i.	U- 0.504	R-2.3
Wall, Below Grade						
Below Grade Wall	C- 0.522	R-1.8 c.i.	C- 0.358	R-2.6 c.i.	C- 0.678	R-1.3 c.i
Floors						
Mass	U- 0.287	R-2.9 c.i.	U- 0.287	R-2.9 c.i.	U- 0.496	R-1.5 c.i.
Steel Joist	U- 0.183	R-6.7	U- 0.183	R-6.7	U- 0.296	R-3.3
Wood Framed and Other	U- 0.153	R-6.7	U- 0.153	R-6.7	U- 0.288	R-3.3
Slab-On-Grade Floors						
Unheated	F- 0.882	R-3.5 for 600 mm	F- 0.750	R-3.5 for 1200 mm	F- 1.264	NR
Heated	F- 1.191	R-3.5 for 1200 mm	F- 1.162	R-4.4 for 1200 mm	F- 1.489	R-2.6 for 600 mm
Opaque Doors						
Swinging	U- 2.839		U- 2.839		U- 3.975	
Non-Swinging	U- 2.839		U- 2.839		U- 2.839	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.82			U- 1.82			U- 2.56		
Metal framing, fixed	U- 2.38			U- 2.38			U- 2.90		
Metal framing, operable	U- 2.84	SHGC-0.40	1.10	U- 2.84	SHGC-0.40	1.10	U- 3.35	NR	NR
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 2.84	SHGC-0.40	NR	U- 2.84	SHGC-0.40	NR	U- 4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

[b] Exception to Section 5.5.3.2 applies for mass walls above grade.

TABLE 5.5-7 Building Envelope Requirements For Climate Zone 7 (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.158	R-6.2 c.i.	U- 0.158	R-6.2 c.i.	U- 0.220	R-4.4 c.i.
Metal Building[a]	U- 0.163	R-5.3 + R-1.9 Ls	U- 0.163	R-5.3 + R-1.9 Ls	U- 0.210	R-3.3 + R-1.9 Ls or R-4.4. + R-1.4 Ls
Attic and Other	U- 0.098	R-10.6	U- 0.098	R-10.6	U- 0.153	R-6.7 c.i.
Walls, Above Grade						
Mass	U- 0.404	R-2.7 c.i.	U- 0.404	R-2.7 c.i.	U- 0.701	R-1.3 c.i.
Metal Building	U- 0.248	R-0 + R-3.9 c.i.	U- 0.248	R-0 + R-3.9 c.i.	U- 0.410	R-0 + R-2.3 c.i.
Steel Framed	U- 0.277	R-2.3 + R-2.2 c.i.	U- 0.240	R-2.3 + R-2.7 c.i.	U- 0.365	R-2.3 + R-1.3 c.i.
Wood Framed and Other	U- 0.291	R-2.3 + R-1.3 c.i. or R-3.3 + R-0.9 c.i.	U- 0.291	R-2.3 + R-1.3 c.i. or R-3.3 + R-0.9 c.i.	U- 0.365	R-2.3 + R-0.7 c.i.
Wall, Below Grade						
Below Grade Wall	C- 0.358	R-2.6 c.i.	C- 0.358	R-2.6 c.i.	C- 0.678	R-1.3 c.i.
Floors						
Mass	U- 0.236	R-3.7 c.i.	U- 0.236	R-3.7 c.i.	U- 0.420	R-1.8 c.i.
Steel Joist	U- 0.183	R-6.7	U- 0.183	R-6.7	U- 0.296	R-3.3
Wood Framed and Other	U- 0.153	R-6.7	U- 0.153	R-6.7	U- 0.288	R-3.3
Slab-On-Grade Floors						
Unheated	F- 0.882	R-3.5 for 600 mm	F- 0.750	R-3.5 for 1200 mm	F- 1.264	NR
Heated	F- 1.162	R-4.4 for 1200 mm	F- 1.162	R-4.4 for 1200 mm	F- 1.489	R-2.6 for 600 mm
Opaque Doors						
Swinging	U- 2.839		U- 2.839		U- 3.975	
Non-Swinging	U- 2.839		U- 2.839		U- 2.839	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.82			U- 1.82			U- 1.82		
Metal framing, fixed	U- 2.16			U- 2.16			U- 2.16		
Metal framing, operable	U- 2.27	SHGC- 0.45	1.10	U- 2.27	SHGC- 0.45	1.10	U- 2.50	NR	NR
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 2.84	NR	NR	U- 2.84	NR	NR	U- 4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5-8 Building Envelope Requirements For Climate Zone 8 (SI)*

	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
OPAQUE ELEMENTS	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**	**Assembly Maximum**	**Insulation Min. R -Value**
Roofs						
Insulation Entirely above Deck	U- 0.158	R-6.2 c.i.	U- 0.158	R-6.2 c.i.	U- 0.220	R-4.4 c.i.
Metal Building[a]	U- 0.147	R-4.4 + R-1.9 + R-1.9 Ls	U- 0.147	R-4.4 + R-1.9 + R-1.9 Ls	U- 0.210	R-3.3 + R-1.9 Ls or R-4.4 + R-1.4 Ls
Attic and Other	U- 0.098	R-10.6	U- 0.098	R-10.6	U- 0.153	R-6.7 c.i.
Walls, Above Grade						
Mass	U- 0.273	R-3.3 c.i.	U- 0.273	R-3.3 c.i.	U- 0.592	R-1.7 c.i.
Metal Building	U- 0.220	R-0 + R-4.4 c.i.	U- 0.220	R-0 + R-4.4 c.i.	U- 0.341	R-0 + R-2.8 c.i.
Steel Framed	U- 0.212	R-2.3 + R-3.3 c.i.	U- 0.212	R-2.3 + R-3.3 c.i.	U- 0.365	R-2.3 + R-1.3 c.i.
Wood Framed and Other	U- 0.182	R-2.3 + R-3.3 c.i.	U- 0.182	R-2.3 + R-3.3 c.i.	U- 0.291	R-2.3 + R-1.3 c.i.
Wall, Below Grade						
Below Grade Wall	C- 0.358	R-2.6 c.i.	C- 0.358	R-2.6 c.i.	C- 0.678	R-1.3 c.i.
Floors						
Mass	U- 0.217	R-4.1 c.i.	U- 0.217	R-4.1 c.i.	U- 0.363	R-2.2 c.i.
Steel Joist	U- 0.183	R-6.7	U- 0.183	R-6.7	U- 0.296	R-3.3
Wood Framed and Other	U- 0.153	R-6.7	U- 0.153	R-6.7	U- 0.188	R-5.3
Slab-On-Grade Floors						
Unheated	F- 0.750	R-3.5 for 1200 mm	F- 0.734	R-4.4 for 1200 mm	F- 0.935	R-1.8 for 600 mm
Heated	F- 1.162	R-4.4 for 1200 mm	F- 0.646	R-3.5 full slab	F- 1.489	R-2.6 for 600 mm
Opaque Doors						
Swinging	U- 2.839		U- 2.839		U- 2.839	
Non-Swinging	U- 2.839		U- 2.839		U- 2.839	

FENESTRATION	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Min. VT/ SHGC**
Vertical Fenestration, 0-40% of Wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U- 1.82			U- 1.82			U- 1.82		
Metal framing, fixed	U- 2.16	SHGC-0.45	1.10	U- 2.16	SHGC-0.45	1.10	U- 2.16	NR	NR
Metal framing, operable	U- 2.27			U- 2.27			U- 2.50		
Metal framing, entrance door	U- 4.37			U- 3.86			U- 4.37		
Skylight, 0-3% of Roof									
All types	U- 2.84	NR	NR	U- 2.84	NR	NR	U- 4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), FC = filled cavity (see Section A2.3.2.5), Ls = liner system (see Section A2.3.2.4), NR = no (insulation) requirement.

[a] When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see Section A2.3.2).

TABLE 5.5.3.1 High Albedo Roof Insulation*

Climate Zone	Opaque Elements (Roofs)	Nonresidential		Residential	
		Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
1	Insulation entirely above deck	U-0.062	R-16 c.i.	U-0.050	R-20 c.i.
	Metal building	U-0.053	R-10 + R-19 FC	U-0.053	R-10 + R-19 FC
	Attic and other[a]	U-0.035	R-30	U-0.022	R-30
2	Insulation entirely above deck	U-0.047	R-21 c.i.	U-0.047	R-21 c.i.
	Metal building	U-0.049	R-10 + R-19 FC	U-0.049	R-10 + R-19 FC
	Attic and other[a]	U-0.032	R-32	U-0.032	R-32
3	Insulation entirely above deck	U-0.046	R-21 c.i.	U-0.046	R-21 c.i.
	Metal building	U-0.048	R-10 + R-19 FC	U-0.048	R-10 + R-19 FC
	Attic and other[a]	U-0.032	R-42	U-0.032	R-32
4, 5, 6, 7, 8	All roof opaque elements	NP	NP	NP	NP

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), Ls = liner system (see Section A2.3.2.4) but without a thermal spacer block for this table only NP = not permitted.
[a] Excludes roofs over ventilated attics, or roofs over semiheated spaces, or roofs over conditioned spaces that are not cooled spaces.

TABLE 5.5.3.1 High Albedo Roof Insulation*

Climate Zone	Opaque Elements (Roofs)	Nonresidential		Residential	
		Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
1	Insulation entirely above deck	U-0.355	R-2.7 c.i.	U-0.286	R-3.4 c.i.
	Metal building	U-0.302	R-1.8 + R-3.3 FC	U-0.301	R-1.8 + R-3.3 FC
	Attic and other[a]	U-0.198	R-5.3	U-0.198	R-5.3
2	Insulation entirely above deck	U-0.265	R-3.6 c.i.	U-0.265	R-3.6 c.i.
	Metal building	U-0.280	R-1.8 + R-3.3 FC	U-0.280	R-1.8 + R-3.3 FC
	Attic and other[a]	U-0.184	R-5.6	U-0.184	R-5.6
3	Insulation entirely above deck	U-0.259	R-3.7 c.i.	U-0.259	R-3.7 c.i.
	Metal building	U-0.274	R-1.8 + R-3.3 FC	U-0.274	R-1.8 + R-3.3 FC
	Attic and other[a]	U-0.180	R-5.6	U-0.180	R-5.6
4, 5, 6, 7, 8	All roof opaque elements	NP	NP	NP	NP

* The following definitions apply: c.i. = continuous insulation (see Section 3.2), Ls = liner system (see Section A2.3.2.4) but without a thermal spacer block for this table only NP = not permitted.
[a] Excludes roofs over ventilated attics, or roofs over semiheated spaces, or roofs over conditioned spaces that are not cooled spaces.

Modify Section 5.2.1 as follows (I-P and SI Units).

5.2.1 Compliance. For the appropriate climate, *space-conditioning category*, and *class of construction*, the *building envelope* shall comply with Section 5.1, General; Section 5.4, Mandatory Provisions; Section 5.7, Submittals; and Section 5.8, Product Information and Installation Requirements; and either

a. Section 5.5, Prescriptive Building Envelope Option, provided that the *fenestration area* does not exceed the maximum allowed by Section 5.5.4.2, or
   ~~1. the *vertical fenestration area* does not exceed 40% of the *gross wall area* for each *space-conditioning category* and~~
   ~~2. the *skylight fenestration area* does not exceed 5% of the *gross roof area* for each *space-conditioning category*, or~~

b. Section 5.6, Building Envelope Trade-Off Option.

Modify Section 5.5.3.2 as follows (I-P and SI units).

5.5.3.2 Above-Grade Wall Insulation. All *above-grade walls* shall comply with the insulation values specified in Tables 5.5-1 through 5.5-8.

Exception: Alternatively, for *mass walls*, where the requirement in Tables 5.5-1 through 5.5-8 is for a maximum assembly U-0.151 (U-0.86) followed by footnote "b," ASTM C90 concrete block walls, ungrouted or partially grouted at 32 in. (800 mm) or less on center vertically and 48 in. (1200 mm) or less on center horizontally, shall have ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu·in./h·ft^2·°F (0.063 W/m·K). Other *mass walls* with integral insulation shall meet the criteria when their *U-factors* are equal to or less than those for the appropriate thickness and density in the "Partly Grouted Cells Insulated" column of Table A3.1C.

When a *wall* consists of *above-grade* and *below-grade* portions, the entire *wall* for that story shall be insulated on either the exterior or the interior or be integral.

a. If insulated on the interior, the *wall* shall be insulated to the *above-grade wall* requirements.
b. If insulated on the exterior or integral, the *below-grade wall* portion shall be insulated to the *below-grade wall* requirements, and the *above-grade wall* portion shall be insulated to the *above-grade wall* requirements.

Modify Section 5.5.4 as follows (I-P and SI units).

5.5.4 Fenestration

5.5.4.1 General. Compliance with *U-factors*, ~~and~~ *SHGC*, and *VT* shall be demonstrated for the overall fenestration product. Gross wall areas and gross roof areas shall be calculated separately for each *space-conditioning category* for the purposes of determining compliance.

Exception: If there are multiple assemblies within a single *class of construction* for a single *space-conditioning category*, compliance shall be based on an area-weighted average *U-factor* or *SHGC* or *VT*. It is not acceptable to do an area-weighted average across multiple *classes of construction* or multiple *space-conditioning categories*.

5.5.4.2 Fenestration Area

5.5.4.2.1 Vertical Fenestration Area. The total *vertical fenestration area* shall not be greater than that specified in Tables 5.5-1 through 5.5-8 ~~less than 40% of the *gross wall area*~~.

Exception: *Vertical fenestration* complying with Exception (~~b~~c) to Section 5.5.4.4.1.

5.5.4.2.2 Skylight Fenestration Area. The total *skylight area* shall not be greater than that specified in Tables 5.5-1 through 5.5-8 ~~less than 5% of the *gross roof area*~~.

Exception: The total s*kylight area* is permitted to be increased to no greater than 6% of the *gross roof area* provided the skylights meet all of the criteria in (a) though (c) of the Exception to Section 5.5.4.4.2 and the total *daylight area under skylights* is a minimum of half the floor area of the space.

5.5.4.3 Fenestration U-factor. Fenestration shall have a *U-factor* not greater than that specified in Tables 5.5-1 though 5.5-8 ~~for the appropriate *fenestration area*~~.

However, for locations in Climate Zone 1 with a *cooling design temperature* of 95°F (35°C) and greater, the maximum allowed U-factors for *vertical fenestration* for all *conditioned spaces*, *nonresidential* and *residential*, are: U-0.32 (U-1.82) for *nonmetal framing*, U-0.50 (U-2.84) for *metal framing fixed*, U-0.65 (U-3.69) for *metal framing operable*, and U-0.83 (U-4.71) for *metal framing entrance doors*.

Exception: The U-factor for skylights is permitted to be increased to no greater than 0.90 Btu/h·ft^2·°F (5.11 W/m^2·K) in Climate Zones 1 through 3 and 0.75 Btu/h·ft^2·°F (4.26 W/m^2·K) in Climate Zones 4 through 8 provided the skylights meet all of the criteria in (a) through (c) of the Exception to Section 5.5.4.4.2.

5.5.4.4 Fenestration Solar Heat Gain Coefficient (SHGC)

5.5.4.4.1 SHGC of Vertical Fenestration. *Vertical fenestration* shall have an *SHGC* not greater than that specified ~~for "all" orientations~~ in Tables 5.5-1 through 5.5-8 ~~for the appropriate total *vertical fenestration area*~~.

Exceptions:

a. For demonstrating compliance for *vertical fenestration* shaded by opaque permanent projections that will last as long as the building itself, the *SHGC* in the proposed building shall be reduced by using the multipliers in Table 5.5.4.4.1. Permanent projections consisting of open louvers shall be considered to provide shading, provided that no sun penetrates the louvers during the peak sun angle on June 21.
b. For demonstrating compliance for *vertical fenestration* shaded by partially opaque permanent projections (e.g., framing with glass or perforated metal) that will last as long as the building itself, the *PF* shall be reduced by multiplying it by a factor of O_s, which is derived as follows:

$$O_s = (A_i \cdot O_i) + (A_f \cdot O_f)$$

where

O_s = percent opacity of the shading device

A_i = percent of the area of the shading device that is a partially opaque infill

O_i = percent opacity of the infill—for glass O_i = (100% – T_s), where T_s is the solar transmittance as determined in accordance with NFRC 300; for perforated or decorative metal panels O_i = percentage of solid material

A_f = percent of the area of the shading device that represents the framing members

O_f = percent opacity of the framing members; if solid, then 100%

TABLE 5.5.4.4.1 SHGC Multipliers for Permanent Projections

Projection Factor	SHGC Multiplier (All Other Orientations)	SHGC Multiplier (North-Oriented)
0–0.10	1.00	1.00
>0.10–0.20	0.91	0.95
>0.20–0.30	0.82	0.91
>0.30–0.40	0.74	0.87
>0.40–0.50	0.67	0.84
>0.50–0.60	0.61	0.81
>0.60–0.70	0.56	0.78
>0.70–0.80	0.51	0.76
>0.80–0.90	0.47	0.75
>0.90–1.00	0.44	0.73

And then the *SHGC* in the proposed building shall be reduced by using the multipliers in Table 5.5.4.4.1 for each *fenestration* product.

c. *Vertical fenestration* that is located on the street side of the street-level story only, provided that
   1. the street side of the street-level story does not exceed 20 ft (6 m) in height,
   2. the *fenestration* has a continuous overhang with a weighted average *PF* greater than 0.5, and
   3. the *fenestration area* for the street side of the street-level story is less than 75% of the *gross wall area* for the street side of the street-level story.

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

d. *Vertical fenestration* that is *north-oriented* shall be allowed to have a maximum *solar heat gain coefficient* SHGC-0.05 greater than that specified in Tables 5.5-5 through 5.5-8. When this exception is utilized, separate calculations shall be performed for these sections of the *building envelope*, and these values shall not be averaged with any others for compliance purposes.

5.5.4.4.2 SHGC of Skylights. *Skylights* shall have an *SHGC* not greater than that specified ~~for "all" orientations~~ in Tables 5.5-1 through 5.5-8 ~~for the appropriate total *skylight area*~~.

Exception: *Skylights* are exempt from *SHGC* requirements provided they:

a. Have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003.
b. Have a *skylight* ~~VLT~~ *VT* greater than 0.40, and;
c. Have all general lighting in the *daylit area* under the *skylight* controlled by multi-level photocontrols in accordance with Section 9.4.1.4.

5.5.4.5 Visible Transmittance/SHGC Ratio. Where automatic daylighting controls are required in accordance with Section 9.4.1.4, *fenestration* shall have a ratio of *VT* divided by *SHGC* not less than that specified in Tables 5.5-1 though 5.5-8 for the appropriate *fenestration area.*

Exceptions:

a. A *light-to-solar-gain ratio* (LSG) of not less than 1.25 is allowed to be used as an alternative to VT/SHGC. When using this option, the center-of-glass visible transmittance and the center-of-glass solar heat gain coefficient shall be determined in accordance with NFRC 300 and NFRC 301, determined by an independent laboratory or included in a database published by a government agency, and certified by the *manufacturer.*
b. *Fenestration* not covered in the scope of the NFRC 200.
c. *Enclosed spaces* where the *daylight area under rooftop monitors* is greater than 50% of the *enclosed space* floor area.
d. *Enclosed spaces* with *skylight(s)* that comply with Section 5.5.4.2.3.
e. *Enclosed spaces* where the *sidelighting effective aperture* is greater than or equal to 0.15.

Modify Section 11, Table 11.3.1, #5, as follows (I-P and SI units).

TABLE 11.3.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

Proposed Building Design (Column A) Design Energy Cost (DEC)	Budget Building Design (Column B) Energy Cost Budget (ECB)
5. Building Envelope	
All components of the building envelope in the *proposed building design* shall be modeled as shown on architectural drawings or as installed for *existing building* envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. a. Any envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of an envelope assembly must be added to the area of the adjacent assembly of that same type. b. Exterior surfaces whose azimuth orientation and tilt differ by no more than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. c. For exterior roofs other than roofs with ventilated attics, the roof surface may be modeled with a reflectance of 0.45 if the reflectance of the proposed design roof is greater than 0.70 and its emittance is greater than 0.75. The reflectance and emittance shall be tested in accordance with the Exception to Section 5.5.3.1. All other roof surfaces shall be modeled with a reflectance of 0.3. d. Manually operated fenestration shading devices such as blinds or shades shall not be modeled. Permanent shading devices such as fins, overhangs, and lightshelves shall be modeled.	The *budget building design* shall have identical *conditioned floor area* and identical exterior dimensions and orientations as the *proposed building design*, except as noted in (a), (b), and (c) in this clause. a. Opaque assemblies such as roof, floors, doors, and walls shall be modeled as having the same *heat capacity* as the *proposed building design* but with the minimum U-factor required in Section 5.5 for new buildings or *additions* and Section 5.1.3 for *alterations*. b. Roof albedo—All roof surfaces shall be modeled with a reflectivity of 0.3. c. Fenestration—No shading projections are to be modeled; fenestration shall be assumed to be flush with the exterior wall or roof. If the fenestration area for new buildings or *additions* exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. Fenestration U-factor shall be ~~the minimum required~~ equal to the criteria from Tables 5.5-1 through 5.5-8 for the appropriate climate, and the SHGC shall be ~~the maximum allowed~~ equal to the criteria from Tables 5.5-1 through 5.5-8 for the appropriate climate ~~and orientation~~. For portions of those tables where there are no SHGC requirements, the SHGC shall be equal to that determined in accordance with Section C3.5. The VT shall be equal to that determined in accordance with Section C3.5. The fenestration model for envelope *alterations* shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3. **Exception:** When trade-offs are made between an *addition* and an *existing building* as described in the Exception to Section 4.2.1.2, the envelope assumptions for the *existing building* in the *budget building design* shall reflect existing conditions prior to any revisions that are part of this permit.

Add the following reference to Section 12 (I-P and SI units).

National Fenestration Rating Council, 6305 Ivy Lane, Suite 140, Greenbelt, MD 20770	
NFRC 301-2010	Standard Test Method for Emittance of Specular Surfaces Using Spectrometric Measurements

Modify Appendix A, Section A2.3, as follows (I-P and SI units).

A2.3 Metal Building Roofs

A2.3.1 General. For the purpose of Section A1.2, the base assembly is a *roof* where the insulation is ~~draped over the steel structure (purlins) and then~~ compressed when installed beneath ~~the~~ metal roof panels ~~are~~ attached to the steel structure (purlins). Additional assemblies include *continuous insulation,* uncompressed and uninterrupted by framing. Insulation exposed to a *conditioned space* or *semiheated space* shall have a facing, and all insulation seams shall be continuously sealed.

A2.3.2 Rated R-Value of Insulation

A2.3.2.1 Single Layer. The ~~first~~ *rated R-value of insulation* is for insulation installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached~~, or for insulation hung between the purlins~~. A minimum ~~R-3.5~~ R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required ~~when specified in Table A2.3~~, unless compliance is shown by the overall assembly U-factor.

A2.3.2.2 Double Layer. ~~For double-layer installations, the~~ The first *rated R-value of insulation* is for insulation installed perpendicular to and draped over purlins. The second *rated R-value of insulation* is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.

A2.3.2.3 Continuous Insulation. For assemblies with *continuous insulation*~~, (e.g., insulation boards, or blankets or insulated metal panels), it is assumed that~~ the *continuous insulation* is installed above or below the purlins ~~and is~~, uncompressed and uninterrupted by framing members. ~~Insulation exposed to the *conditioned space* or *semiheated space* shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.~~

A2.3.2.4 Liner System (Ls). A continuous ~~vapor barrier liner~~ membrane is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the ~~liner~~ membrane between the purlins. For multilayer installations, the last *rated R-value of insulation* is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum ~~R-3.5~~ R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required ~~when specified in Table A2.3~~, unless compliance is shown by the overall assembly U-factor.

A2.3.2.5 Filled Cavity. The first *rated R-value of insulation* represents faced or unfaced insulation installed between the purlins. The second *rated R-value of insulation* represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal roof panels are attached. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation. A minimum R-5 (R-0.9) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.

A2.3.3 U-factors for Metal Building Roofs. *U-factors* for *metal building roofs* shall be taken from Table A2.3 or determined in accordance with Section A9.2, provided the average purlin spacing for systems with compressed insulation is at least 52 in. (1300 mm). ~~It is not acceptable to use these *U-factors* if additional insulated sheathing is not continuous.~~ *U-factors* for *metal building roof* assemblies with average purlin spacing less than 52 in. (1300 mm) shall be determined in accordance with Section A9.2. *U-factors* in Table A2.3 shall not be used where the insulation is substantially compressed by the bracing between the purlins.

Delete Table A2.3 in its entirety and replace with the following.

I-P units:

TABLE A2.3 Assembly U-Factors for Metal Building Roofs (I-P)

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (Uninterrupted by Framing)								
			Rated R-Value of Continuous Insulation								
			R-6.5	R-9.8	R-13	R-15.8	R-19	R-22.1	R-25	R-32	R-38
Standing Seam Roofs with Thermal Spacer Blocks[a, b]											
Single Layer	None	1.280	0.137	0.095	0.073	0.060	0.051	0.044	0.039	0.031	0.026
	R-10	0.115	0.066	0.054	0.046	0.041	0.036	0.032	0.030	0.025	0.021
	R-11	0.107	0.063	0.052	0.045	0.040	0.035	0.032	0.029	0.024	0.021
	R-13	0.101	0.061	0.051	0.044	0.039	0.035	0.031	0.029	0.024	0.021
	R-16	0.096	0.059	0.049	0.043	0.038	0.034	0.031	0.028	0.024	0.021
	R-19	0.082	0.053	0.045	0.040	0.036	0.032	0.029	0.027	0.023	0.020
Double Layer	R-10 + R-10	0.088	0.056	0.047	0.041	0.037	0.033	0.030	0.028	0.023	0.020
	R-10 + R-11	0.086	0.055	0.047	0.041	0.036	0.033	0.030	0.027	0.023	0.020
	R-11 + R-11	0.085	0.055	0.046	0.040	0.036	0.033	0.030	0.027	0.023	0.020
	R-10 + R-13	0.084	0.054	0.046	0.040	0.036	0.032	0.029	0.027	0.023	0.020
	R-11 + R-13	0.082	0.053	0.045	0.040	0.036	0.032	0.029	0.027	0.023	0.020
	R-13 + R-13	0.075	0.050	0.043	0.038	0.034	0.031	0.028	0.026	0.022	0.019
	R-10 + R-19	0.074	0.050	0.043	0.038	0.034	0.031	0.028	0.026	0.022	0.019
	R-11 + R-19	0.072	0.049	0.042	0.037	0.034	0.030	0.028	0.026	0.022	0.019
	R-13 + R-19	0.068	0.047	0.041	0.036	0.033	0.030	0.027	0.025	0.021	0.019
	R-16 + R-19	0.065	0.046	0.040	0.035	0.032	0.029	0.027	0.025	0.021	0.019
	R-19 + R-19	0.060	0.043	0.038	0.034	0.031	0.028	0.026	0.024	0.021	0.018
Liner System	R-19 + R-11	0.037									
	R-25 + R-8	0.037									
	R-25 + R-11	0.031									
	R-30 + R-11	0.029									
	R-25 + R-11 + R-11	0.026									
Filled Cavity with Thermal Spacer Blocks[c]											
	R-10+R-19	0.041	0.032	0.029	0.027	0.025	0.023	0.022	0.020	0.018	0.016
Standing Seam Roofs without Thermal Spacer Blocks											
Liner System	R-19+R-11	0.040									
Thru-Fastened Roofs without Thermal Spacer Blocks											
	R-10	0.184	0.084	0.066	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-11	0.182	0.083	0.065	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-13	0.174	0.082	0.064	0.053	0.046	0.040	0.036	0.033	0.026	0.023
	R-16	0.157	0.078	0.062	0.052	0.045	0.039	0.035	0.032	0.026	0.023
	R-19	0.151	0.076	0.061	0.051	0.045	0.039	0.035	0.032	0.026	0.022
Liner System	R-19+R-11	0.044									
(Multiple R-values are listed in order from inside to outside)											

TABLE A2.3 Assembly U-Factors for Metal Building Roofs (I-P)

a. A standing seam roof clip that provides a minimum 1.5 in. distance between the top of the purlins and the underside of the metal roof panels is required.
b. A minimum R-3 thermal spacer block is required.
c. A minimum R-5 thermal spacer block is required.

SI Units:

TABLE A2.3 Assembly U-Factors for Metal Building Roofs (SI)

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (Uninterrupted by Framing) — Rated R-Value of Continuous Insulation								
			R-1.1	R-1.7	R-2.3	R-2.8	R-3.3	R-3.9	R-4.4	R-5.6	R-6.7
Standing Seam Roofs with Thermal Spacer Blocks[a, b]											
Single Layer	None	7.27	0.780	0.54	0.41	0.34	0.29	0.25	0.22	0.17	0.15
	R-1.8	0.653	0.37	0.31	0.26	0.23	0.21	0.18	0.17	0.14	0.12
	R-1.9	0.608	0.36	0.30	0.25	0.23	0.20	0.18	0.17	0.14	0.12
	R-2.3	0.573	0.35	0.29	0.25	0.22	0.20	0.18	0.16	0.14	0.12
	R-2.8	0.55	0.34	0.28	0.24	0.22	0.19	0.17	0.16	0.13	0.12
	R-3.3	0.47	0.30	0.26	0.23	0.20	0.18	0.17	0.15	0.13	0.11
Double Layer	R-1.8 + R-1.8	0.50	0.32	0.27	0.23	0.21	0.19	0.17	0.16	0.13	0.12
	R-1.8 + R-1.9	0.49	0.31	0.26	0.23	0.21	0.19	0.17	0.16	0.13	0.11
	R-1.9 + R-1.9	0.48	0.31	0.26	0.23	0.21	0.18	0.17	0.15	0.13	0.11
	R-1.8 + R-2.3	0.48	0.31	0.26	0.23	0.20	0.18	0.17	0.15	0.13	0.11
	R-1.9 + R-2.3	0.47	0.30	0.26	0.23	0.20	0.18	0.17	0.15	0.13	0.11
	R-2.3 + R-2.3	0.43	0.28	0.25	0.22	0.19	0.18	0.16	0.15	0.13	0.11
	R-1.8 + R-3.3	0.42	0.28	0.24	0.22	0.19	0.17	0.16	0.15	0.12	0.11
	R-1.9 + R-3.3	0.41	0.28	0.24	0.21	0.19	0.17	0.16	0.15	0.12	0.11
	R-2.3 + R-3.3	0.39	0.27	0.23	0.20	0.19	0.17	0.15	0.14	0.12	0.11
	R-2.8 + R-3.3	0.37	0.26	0.23	0.20	0.18	0.17	0.15	0.14	0.12	0.11
	R-3.3 + R-3.3	0.34	0.25	0.21	0.19	0.17	0.16	0.15	0.14	0.12	0.10
Liner System	R-3.3 + R-1.9	0.21									
	R-4.4 +R-1.4	0.21									
	R-4.4 + R-1.9	0.18									
	R-5.3 + R-1.9	0.16									
	R-4.4 + R-1.9 + R-1.9	0.15									
Filled Cavity with Thermal Spacer Blocks[c]											
	R-1.8 + R-3.3	0.23	0.18	0.17	0.15	0.14	0.13	0.14	0.11	0.10	0.09
Standing Seam Roofs without Thermal Spacer Blocks											
Liner System	R-3.3 + R-1.9	0.23									
Thru-Fastened Roofs without Thermal Spacer Blocks											
	R-1.8	1.04	0.48	0.37	0.31	0.27	0.23	0.21	0.19	0.15	0.13
	R-1.9	1.03	0.47	0.37	0.31	0.27	0.23	0.21	0.19	0.15	0.13
	R-2.3	0.988	0.46	0.37	0.30	0.26	0.23	0.20	0.18	0.15	0.13
	R-2.8	0.891	0.44	0.35	0.29	0.26	0.22	0.20	0.18	0.15	0.13
	R-3.3	0.857	0.43	0.35	0.29	0.25	0.22	0.20	0.18	0.15	0.13

TABLE A2.3 Assembly U-Factors for Metal Building Roofs (SI)

Liner System	R-3.3 + R-1.9	0.25
(Multiple R-values are listed in order from inside to outside)		

a. A standing seam roof clip that provides a minimum 3.8 cm distance between the top of the purlins and the underside of the metal roof panels is required.
b. A minimum R-0.5 thermal spacer block is required.
c. A minimum R-0.9 thermal spacer block is required.

Modify Appendix A, Section A3.1, as follows (I-P and SI units).

A3.1 Mass Wall

A3.1.1 General. For the purpose of A1.2, the base assembly is a masonry or concrete *wall*. *Continuous insulation* is installed on the interior, exterior, or within the masonry units, or it is installed on the interior or exterior of the concrete. The brick cavity wall has continuous insulation between the brick and the concrete or masonry. The *U-factor* includes R-0.17 (R-0.03) for exterior air film and R-0.68 (R-0.12) for interior air film, vertical surfaces. For insulated walls, the U-factor also includes R-0.45 (R-0.08) for 0.5 in. (13 mm) gypsum board. For the cavity wall, the U-factor includes R-0.74 (R-0.13) for brick.

U-factors are provided for the following configurations:

a. Concrete *wall*: 8 in. (200 mm) normal weight concrete wall with a density of 145 lb/ft^3 (2320 kg/m^3).
b. Solid grouted concrete block *wall*: 8 in. (200 mm) medium weight ASTM C90 concrete block with a density of 115 lb/ft^3 (1840 kg/m^3) and solid grouted cores.
c. Partially grouted concrete block *wall*: 8 in. (200 mm) medium weight ASTM C90 concrete block with a density of 115 lb/ft^3 (1840 kg/m^3) having reinforcing steel every 32 in. (800 mm) vertically and every 48 in. (1200 mm) horizontally, with cores grouted in those areas only. Other cores are filled with insulating material only if there is no other insulation.

...

A3.1.3.1 *U-factors* for *mass walls* shall be taken from Table A3.1A or determined by the procedure in this subsection. It is acceptable to use the *U-factors* in Table A3.1A for all *mass walls*, provided that the grouting is equal to or less than that specified. *Heat capacity* for *mass walls* shall be taken from Table A3.1B or A3.1C.

~~**Exception to A3.1.3.1:** For *mass walls*, where the requirement in Tables 5.5-1 through 5.5-8 is for a maximum assembly U-0.151 (U-0.86) followed by footnote "a," ASTM C90 concrete block walls, ungrouted or partially grouted at 32 in. (800 mm) or less on center vertically and 48 in. (1200 mm) or less on center horizontally, shall have ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu·in./h·ft²·°F (0.063 W/m·K). Other *mass walls* with integral insulation shall meet the criteria when their *U-factors* are equal to or less than those for the appropriate thickness and density in the "Partly Grouted Cells Insulated" column of Table A3.1C.~~

…

The remainder of the section is unchanged.

Modify Appendix A, Section A3.2, as follows (I-P and SI units).

A3.2 Metal Building Walls

A3.2.1 General. For the purpose of Section A1.2, the base assembly is a *wall* where the insulation is compressed between metal wall panels and the metal structure. Additional assemblies include *continuous insulation*, uncompressed and uninterrupted by framing. Insulation exposed to a *conditioned space* or *semiheated space* shall have a facing, and all insulation shall be continuously sealed to provide a continuous air barrier.

A3.2.2 Rated R-Value of Insulation for Metal Building Walls

A3.2.2.1 Single Layer. The first *rated R-Value of insulation* is for insulation compressed between metal wall panels and the steel structure.

~~**A3.2.2.2** For double-layer installations, the second *rated R-value of insulation* is for insulation installed from the inside, covering the girts.~~

A3.2.2.~~3~~2 ***Continuous Insulation.*** For assemblies with *continuous insulation*~~, (e.g., insulation boards) it is assumed that~~ the *continuous insulation* ~~boards are~~ is installed on the outside or inside ~~of~~ the girts, uncompressed and uninterrupted by the framing members.

~~**A3.2.2.4** Insulation exposed to the *conditioned space* or *semiheated space* shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.~~

A3.2.3 U-Factors for Metal Building Walls. *U-factors* for metal building walls shall be taken from Table A3.2 or determined in accordance with Section A9.2, provided the average girt spacing is at least 52 in. (1300 mm). ~~It is not acceptable to use these *U-factors* if additional insulation is not continuous.~~ *U-factors* for *metal building wall* assemblies with average girt spacing less than 52 in. (1300 mm) shall be determined in accordance with Section A9.2.

Modify Table A3.1A as follows.

I-P units:

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft^3 Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	R-0	U-0.740	U-0.580	U-0.480
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-0.350
Continuous metal framing at 24 in. on center horizontally				
1.0 in.	R-0	U-0.414	U-0.359	U-0.318
1.0 in.	R-3.8	U-0.325	U-0.290	U-0.263
1.0 in.	R-5	U-0.314	U-0.281	U-0.255
1.0 in.	R-6.5	U-0.305	U-0.274	U-0.249
1.5 in.	R-11	U-0.267	U-0.243	U-0.223
2.0 in.	R-7.6	U-0.230	U-0.212	U-0.197
2.0 in.	R-10	U-0.219	U-0.202	U-0.188
2.0 in.	R-13	U-0.210	U-0.195	U-0.182
3.0 in.	R-11.4	U-0.178	U-0.167	U-0.157
3.0 in.	R-15	U-0.168	U-0.158	U-0.149
3.0 in.	R-19.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-11.0	U-0.168	U-0.158	U-0.149
3.5 in.	R-13.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-15.0	U-0.155	U-0.147	U-0.140
4.5 in.	R-17.1	U-0.133	U-0.126	U-0.121
4.5 in.	R-22.5	U-0.124	U-0.119	U-0.114
4.5 in.	R-25.2	U-0.122	U-0.116	U-0.112
5.0 in.	R-19.0	U-0.122	U-0.117	U-0.112
5.0 in.	R-25.0	U-0.115	U-0.110	U-0.106
5.0 in.	R-28.0	U-0.112	U-0.107	U-0.103
5.0 in.	R-32.0	U-0.109	U-0.105	U-0.101
5.5 in.	R-19.0	U-0.118	U-0.113	U-0.109
5.5 in.	R-20.9	U-0.114	U-0.109	U-0.105
5.5 in.	R-21.0	U-0.113	U-0.109	U-0.105

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls ***(Continued)***

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft^3 Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	**R-0**	**U-0.740**	**U-0.580**	**U-0.480**
	Ungrouted Cores Filled with Loose-Fill Insulation	**N.A.**	**N.A.**	**U-0.350**
5.5 in.	R-27.5	U-0.106	U-0.102	U-0.099
5.5 in.	R-30.8	U-0.104	U-0.100	U-0.096
6.0 in.	R-22.8	U-0.106	U-0.102	U-0.098
6.0 in.	R-30.0	U-0.099	U-0.095	U-0.092
6.0 in.	R-33.6	U-0.096	U-0.093	U-0.090
6.5 in.	R-24.7	U-0.099	U-0.096	U-0.092
7.0 in.	R-26.6	U-0.093	U-0.090	U-0.087
7.5 in.	R-28.5	U-0.088	U-0.085	U-0.083
8.0 in.	R-30.4	U-0.083	U-0.081	U-0.079
1 in. metal clips at 24 in. on center horizontally and 16 in. vertically				
1.0 in.	R-3.8	U-0.210	U-0.195	U-0.182
1.0 in.	R-5.0	U-0.184	U-0.172	U-0.162
1.0 in.	R-5.6	U-0.174	U-0.163	U-0.154
1.5 in.	R-5.7	U-0.160	U-0.151	U-0.143
1.5 in.	R-7.5	U-0.138	U-0.131	U-0.125
1.5 in.	R-8.4	U-0.129	U-0.123	U-0.118
2.0 in.	R-7.6	U-0.129	U-0.123	U-0.118
2.0 in.	R-10.0	U-0.110	U-0.106	U-0.102
2.0 in.	R-11.2	U-0.103	U-0.099	U-0.096
2.5 in.	R-9.5	U-0.109	U-0.104	U-0.101
2.5 in.	R-12.5	U-0.092	U-0.089	U-0.086
2.5 in.	R-14.0	U-0.086	U-0.083	U-0.080
3.0 in.	R-11.4	U-0.094	U-0.090	U-0.088
3.0 in.	R-15.0	U-0.078	U-0.076	U-0.074
3.0 in.	R-16.8	U-0.073	U-0.071	U-0.069
3.5 in.	R-13.3	U-0.082	U-0.080	U-0.077
3.5 in.	R-17.5	U-0.069	U-0.067	U-0.065
3.5 in.	R-19.6	U-0.064	U-0.062	U-0.061
4.0 in.	R-15.2	U-0.073	U-0.071	U-0.070
4.0 in.	R-20.0	U-0.061	U-0.060	U-0.058
4.0 in.	R-22.4	U-0.057	U-0.056	U-0.054
5.0 in.	R-28.0	U-0.046	U-0.046	U-0.045
6.0 in.	R-33.6	U-0.039	U-0.039	U-0.038
7.0 in.	R-39.2	U-0.034	U-0.034	U-0.033
8.0 in.	R-44.8	U-0.030	U-0.030	U-0.029
9.0 in.	R-50.4	U-0.027	U-0.027	U-0.026
10.0 in.	R-56.0	U-0.024	U-0.024	U-0.024
11.0 in.	R-61.6	U-0.022	U-0.022	U-0.022
Continuous insulation uninterrupted by framing				
No Framing	R-1.0	U-0.425	U-0.367	U-0.324

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls *(Continued)*

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft^3 Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	**R-0**	**U-0.740**	**U-0.580**	**U-0.480**
	Ungrouted Cores Filled with Loose-Fill Insulation	**N.A.**	**N.A.**	**U-0.350**
No Framing	R-2.0	U-0.298	U-0.269	U-0.245
No Framing	R-3.0	U-0.230	U-0.212	U-0.197
No Framing	R-4.0	U-0.187	U-0.175	U-0.164
No Framing	R-5.0	U-0.157	U-0.149	U-0.141
No Framing	R-6.0	U-0.136	U-0.129	U-0.124
No Framing	R-7.0	U-0.120	U-0.115	U-0.110
No Framing	R-8.0	U-0.107	U-0.103	U-0.099
No Framing	R-9.0	U-0.097	U-0.093	U-0.090
No Framing	R-10.0	U-0.088	U-0.085	U-0.083
No Framing	R-11.0	U-0.081	U-0.079	U-0.076
No Framing	R-12.0	U-0.075	U-0.073	U-0.071
No Framing	R-13.0	U-0.070	U-0.068	U-0.066
No Framing	R-14.0	U-0.065	U-0.064	U-0.062
No Framing	R-15.0	U-0.061	U-0.060	U-0.059
No Framing	R-16.0	U-0.058	U-0.056	U-0.055
No Framing	R-17.0	U-0.054	U-0.053	U-0.052
No Framing	R-18.0	U-0.052	U-0.051	U-0.050
No Framing	R-19.0	U-0.049	U-0.048	U-0.047
No Framing	R-20.0	U-0.047	U-0.046	U-0.045
No Framing	R-21.0	U-0.045	U-0.044	U-0.043
No Framing	R-22.0	U-0.043	U-0.042	U-0.042
No Framing	R-23.0	U-0.041	U-0.040	U-0.040
No Framing	R-24.0	U-0.039	U-0.039	U-0.038
No Framing	R-25.0	U-0.038	U-0.037	U-0.037
No Framing	R-30.0	U-0.032	U-0.032	U-0.031
No Framing	R-35.0	U-0.028	U-0.027	U-0.027
No Framing	R-40.0	U-0.024	U-0.024	U-0.024
No Framing	R-45.0	U-0.022	U-0.021	U-0.021
No Framing	R-50.0	U-0.019	U-0.019	U-0.019
No Framing	R-55.0	U-0.018	U-0.018	U-0.018
No Framing	R-60.0	U-0.016	U-0.016	U-0.016
Brick cavity wall with continuous insulation				
No Framing	R-0	U-0.337	U-0.299	U-0.270
No Framing	R-3.8	U-0.148	U-0.140	U-0.133
No Framing	R-5.0	U-0.125	U-0.120	U-0.115
No Framing	R-6.5	U-0.106	U-0.102	U-0.098
No Framing	R-7.6	U-0.095	U-0.091	U-0.088
No Framing	R-10	U-0.077	U-0.075	U-0.073
No Framing	R-10.5	U-0.079	U-0.077	U-0.075
No Framing	R-11.4	U-0.070	U-0.068	U-0.066
No Framing	R-15	U-0.056	U-0.055	U-0.053

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls ***(Continued)***

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft^3 Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	**R-0**	**U-0.740**	**U-0.580**	**U-0.480**
	Ungrouted Cores Filled with Loose-Fill Insulation	**N.A.**	**N.A.**	**U-0.350**
No Framing	R-16.5	U-0.054	U-0.053	U-0.052
No Framing	R-19.0	U-0.046	U-0.045	U-0.044
No Framing	R-22.5	U-0.041	U-0.040	U-0.039
No Framing	R-28.5	U-0.033	U-0.032	U-0.032
Continuous insulation uninterrupted by framing with stucco and continuous metal framing at 24 in. on center horizontally				
1.0 in.	R-0+R-19.0 c.i.	U-0.047	U-0.046	U-0.045
1.0 in.	R-3.8+R-19.0 c.i.	U-0.045	U-0.044	U-0.044
1.0 in.	R-5+R-19.0 c.i.	U-0.045	U-0.044	U-0.043
1.0 in.	R-6.5+R-19.0 c.i.	U-0.045	U-0.044	U-0.043
1.5 in.	R-11+R-19.0 c.i.	U-0.044	U-0.043	U-0.043
2.0 in.	R-7.6+R-19.0 c.i.	U-0.043	U-0.042	U-0.041
2.0 in.	R-10+R-19.0 c.i.	U-0.042	U-0.041	U-0.041
2.0 in.	R-13+R-19.0 c.i.	U-0.042	U-0.041	U-0.041
3.0 in.	R-11.4+R-19.0 c.i.	U-0.041	U-0.040	U-0.039

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls *(Continued)*

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 8 in. Normal Weight 145 lb/ft^3 Solid Concrete Walls	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 8 in. Medium Weight 115 lb/ft^3 Concrete Block Walls: Partially Grouted (Cores Uninsulated Except here specified)
No Framing	R-0	U-0.740	U-0.580	U-0.480
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-0.350
3.0 in.	R-15+R-19.0 c.i.	U-0.040	U-0.039	U-0.039
3.0 in.	R-19.5+R-19.0 c.i.	U-0.040	U-0.039	U-0.038
3.5 in.	R-11.0+R-19.0 c.i.	U-0.040	U-0.039	U-0.039
3.5 in.	R-13.0+R-19.0 c.i.	U-0.040	U-0.039	U-0.038
5.0 in.	R-19.0+R-19.0 c.i.	U-0.037	U-0.036	U-0.036
5.0 in.	R-25+R-19.0 c.i.	U-0.036	U-0.035	U-0.035
5.0 in.	R-32.5+R-19.0 c.i.	U-0.035	U-0.035	U-0.034
5.5 in.	R-19.0+R-19.0 c.i.	U-0.036	U-0.036	U-0.035
5.5 in.	R-21.0+R-19.0 c.i.	U-0.035	U-0.035	U-0.035

SI units:

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 200 mm Normal Weight 2320 kg/m^3 Solid Concrete Walls	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	R-0	U-4.20	U-3.29	U-2.73
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-1.99
Continuous metal framing at 600 mm on center horizontally				
25 mm	R-0.00	U-2.35	U-2.04	U-1.80
25 mm	R-0.67	U-1.84	U-1.64	U-1.49
25 mm	R-0.88	U-1.78	U-1.59	U-1.45
25 mm	R-1.15	U-1.73	U-1.55	U-1.41
38 mm	R-1.94	U-1.51	U-1.38	U-1.26
51 mm	R-1.34	U-1.30	U-1.20	U-1.12
51 mm	R-1.76	U-1.24	U-1.15	U-1.07
51 mm	R-2.29	U-1.19	U-1.11	U-1.03
76 mm	R-2.01	U-1.01	U-0.95	U-0.89
76 mm	R-2.65	U-0.95	U-0.90	U-0.84
76 mm	R-3.35	U-0.91	U-0.86	U-0.82
89 mm	R-1.94	U-0.95	U-0.90	U-0.85
89 mm	R-2.29	U-0.91	U-0.86	U-0.82
89 mm	R-2.64	U-0.88	U-0.83	U-0.80
114 mm	R-3.01	U-0.76	U-0.72	U-0.69
114 mm	R-3.96	U-0.70	U-0.68	U-0.65
114 mm	R-4.44	U-0.69	U-0.66	U-0.64
127 mm	R-3.35	U-0.69	U-0.66	U-0.64

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls ***(Continued)***

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 200 mm Normal Weight 2320 kg/m^3 Solid Concrete Walls	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	R-0	U-4.20	U-3.29	U-2.73
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-1.99
127 mm	R-4.40	U-0.65	U-0.62	U-0.60
127 mm	R-4.93	U-0.64	U-0.61	U-0.59
127 mm	R-5.64	U-0.62	U-0.60	U-0.57
140 mm	R-3.35	U-0.67	U-0.64	U-0.62
140 mm	R-3.69	U-0.65	U-0.62	U-0.60
140 mm	R-3.70	U-0.64	U-0.62	U-0.60
140 mm	R-4.85	U-0.60	U-0.58	U-0.56
140 mm	R-5.43	U-0.59	U-0.57	U-0.55
152 mm	R-4.01	U-0.60	U-0.58	U-0.56
152 mm	R-5.28	U-0.56	U-0.54	U-0.52
152 mm	R-5.92	U-0.55	U-0.53	U-0.51
165 mm	R-4.36	U-0.56	U-0.55	U-0.52
178 mm	R-4.69	U-0.53	U-0.51	U-0.49
191 mm	R-5.03	U-0.50	U-0.48	U-0.47
203 mm	R-5.36	U-0.47	U-0.46	U-0.45
25mm metal clips at 600 mm on center horizontally and 400 mm vertically				
25 mm	R-0.67	U-1.19	U-1.11	U-1.03
25 mm	R-0.88	U-1.05	U-0.98	U-0.92
25 mm	R-0.99	U-0.99	U-0.93	U-0.87
38 mm	R-1.00	U-0.91	U-0.86	U-0.81
38 mm	R-1.32	U-0.78	U-0.74	U-0.71
38 mm	R-1.48	U-0.73	U-0.70	U-0.67
51 mm	R-1.34	U-0.73	U-0.70	U-0.67
51 mm	R-1.76	U-0.62	U-0.60	U-0.58
51 mm	R-1.97	U-0.59	U-0.56	U-0.55
64 mm	R-1.68	U-0.62	U-0.59	U-0.57
64 mm	R-2.20	U-0.52	U-0.51	U-0.49
64 mm	R-2.46	U-0.49	U-0.47	U-0.45
76 mm	R-2.01	U-0.53	U-0.51	U-0.47
76 mm	R-2.64	U-0.44	U-0.43	U-0.42
76 mm	R-2.96	U-0.41	U-0.40	U-0.39
89 mm	R-2.34	U-0.47	U-0.45	U-0.44
89 mm	R-3.08	U-0.39	U-0.38	U-0.37
89 mm	R-3.45	U-0.36	U-0.35	U-0.35
102 mm	R-2.68	U-0.40	U-0.40	U-0.40
102 mm	R-3.52	U-0.34	U-0.33	U-0.33
102 mm	R-3.94	U-0.32	U-0.31	U-0.31
127 mm	R-4.93	U-0.26	U-0.26	U-0.26
152 mm	R-5.92	U-0.22	U-0.22	U-0.22

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls ***(Continued)***

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 200 mm Normal Weight 2320 kg/m^3 Solid Concrete Walls	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	**R-0**	**U-4.20**	**U-3.29**	**U-2.73**
	Ungrouted Cores Filled with Loose-Fill Insulation	**N.A.**	**N.A.**	**U-1.99**
178 mm	R-6.90	U-0.19	U-0.19	U-0.19
203 mm	R-7.89	U-0.17	U-0.17	U-0.16
229 mm	R-8.87	U-0.15	U-0.15	U-0.15
254 mm	R-9.86	U-0.14	U-0.14	U-0.14
279 mm	R-10.8	U-0.12	U-0.12	U-0.12
Continuous insulation uninterrupted by framing				
No Framing	R-0.18	U-2.41	U-2.08	U-1.84
No Framing	R-0.35	U-1.69	U-1.53	U-1.39
No Framing	R-0.53	U-1.31	U-1.20	U-1.12
No Framing	R-0.70	U-1.06	U-0.99	U-0.93
No Framing	R-0.88	U-0.89	U-0.85	U-0.80
No Framing	R-1.06	U-0.77	U-0.73	U-0.70
No Framing	R-1.23	U-0.68	U-0.65	U-0.62
No Framing	R-1.41	U-0.61	U-0.59	U-0.56
No Framing	R-1.58	U-0.55	U-0.53	U-0.51
No Framing	R-1.76	U-0.50	U-0.48	U-0.47
No Framing	R-1.94	U-0.46	U-0.45	U-0.43
No Framing	R-2.11	U-0.43	U-0.41	U-0.40
No Framing	R-2.29	U-0.40	U-0.39	U-0.37
No Framing	R-2.46	U-0.37	U-0.36	U-0.35
No Framing	R-2.64	U-0.35	U-0.34	U-0.34
No Framing	R-2.82	U-0.33	U-0.32	U-0.31
No Framing	R-2.99	U-0.31	U-0.30	U-0.30
No Framing	R-3.17	U-0.30	U-0.29	U-0.28
No Framing	R-3.35	U-0.28	U-0.27	U-0.27
No Framing	R-3.52	U-0.27	U-0.26	U-0.26
No Framing	R-3.70	U-0.26	U-0.25	U-0.24
No Framing	R-3.87	U-0.24	U-0.24	U-0.24
No Framing	R-4.05	U-0.23	U-0.23	U-0.23
No Framing	R-4.23	U-0.22	U-0.22	U-0.22
No Framing	R-4.40	U-0.22	U-0.21	U-0.21
No Framing	R-5.28	U-0.18	U-0.18	U-0.18
No Framing	R-6.16	U-0.16	U-0.15	U-0.15
No Framing	R-7.04	U-0.14	U-0.14	U-0.14
No Framing	R-7.92	U-0.12	U-0.12	U-0.12
No Framing	R-8.80	U-0.11	U-0.11	U-0.11
No Framing	R-9.68	U-0.10	U-0.10	U-0.10
No Framing	R-10.56	U-0.09	U-0.09	U-0.09
Brick cavity wall with continuous insulation				
No Framing	R-0.00	U-1.91	U-1.70	U-1.53

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls *(Continued)*

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 200 mm Normal Weight 2320 kg/m^3 Solid Concrete Walls	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	R-0	U-4.20	U-3.29	U-2.73
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-1.99
No Framing	R-0.67	U-0.84	U-0.79	U-0.75
No Framing	R-0.88	U-0.71	U-0.68	U-0.65
No Framing	R-1.15	U-0.60	U-0.58	U-0.56
No Framing	R-1.34	U-0.54	U-0.52	U-0.50
No Framing	R-1.76	U-0.44	U-0.43	U-0.41
No Framing	R-1.85	U-0.45	U-0.44	U-0.43
No Framing	R-2.01	U-0.40	U-0.39	U-0.37
No Framing	R-2.65	U-0.32	U-0.31	U-0.30
No Framing	R-2.91	U-0.31	U-0.30	U-0.29
No Framing	R-3.35	U-0.26	U-0.25	U-0.25
No Framing	R-3.97	U-0.23	U-0.23	U-0.22

TABLE A3.1A Assembly U-Factors for Above-Grade Concrete Walls and Masonry Walls ***(Continued)***

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for 200 mm Normal Weight 2320 kg/m^3 Solid Concrete Walls	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Solid Grouted	Assembly U-Factors for 200 mm Medium Weight 1840 kg/m^3 Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	R-0	U-4.20	U-3.29	U-2.73
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-1.99
No Framing	R-5.03	U-0.19	U-0.18	U-0.18
Continuous insulation uninterrupted by framing with stucco and continuous metal framing at 600 mm on center horizontally				
25 mm	R-0.00+R-3.35 c.i.	U-0.27	U-0.26	U-0.25
25 mm	R-0.67+R-3.35 c.i.	U-0.26	U-0.25	U-0.25
25 mm	R-0.88+R-3.35 c.i.	U-0.26	U-0.25	U-0.25
25 mm	R-1.15+R-3.35 c.i.	U-0.26	U-0.25	U-0.25
38 mm	R-1.34+R-3.35 c.i.	U-0.25	U-0.24	U-0.24
51mm	R-1.76+R-3.35 c.i.	U-0.24	U-0.24	U-0.23
51 mm	R-2.29+R-3.35 c.i.	U-0.24	U-0.23	U-0.23
51 mm	R-1.06+R-3.35 c.i.	U-0.24	U-0.23	U-0.23
76 mm	R-2.01+R-3.35 c.i.	U-0.23	U-0.23	U-0.22
76 mm	R-2.65+R-3.35 c.i.	U-0.23	U-0.22	U-0.22
76 mm	R-3.44+R-3.35 c.i.	U-0.23	U-0.22	U-0.22
89 mm	R-1.94+R-3.35 c.i.	U-0.23	U-0.22	U-0.22
89 mm	R-2.29+R-3.35 c.i.	U-0.23	U-0.22	U-0.22
127 mm	R-3.35+R-3.35 c.i.	U-0.21	U-0.21	U-0.20
127 mm	R-4.41+R-3.35 c.i.	U-0.20	U-0.20	U-0.20
127 mm	R-5.73+R-3.35 c.i.	U-0.20	U-0.20	U-0.20
140 mm	R-3.17+R-3.35 c.i.	U-0.20	U-0.20	U-0.20
140 mm	R-3.70+R-3.35 c.i.	U-0.20	U-0.20	U-0.20

Delete Table A3.2 in its entirety and replace with the following.

I-P units:

TABLE A3.2 Assembly U-Factors for Metal Building Walls (I-P)

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing)								
			R-6.5	R-9.8	R-13	R-15.8	R-19	R-22.1	R-25	R-32	R-38
Single Layer of Mineral Fiber											
	None	1.180	0.136	0.094	0.072	0.060	0.050	0.044	0.039	0.030	0.026

TABLE A3.2 Assembly U-Factors for Metal Building Walls (I-P)

	R-10	0.186	0.084	0.066	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-11	0.185	0.084	0.066	0.054	0.047	0.041	0.036	0.033	0.027	0.023
	R-13	0.162	0.079	0.063	0.052	0.046	0.040	0.035	0.032	0.026	0.023
	R-16	0.155	0.077	0.062	0.051	0.045	0.039	0.035	0.032	0.026	0.022
	R-19	0.147	0.075	0.060	0.050	0.044	0.039	0.035	0.031	0.026	0.022

SI Units:

TABLE A3.2 Assembly U-Factors for Metal Building Walls (SI)

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing)								
			R-1.1	R-1.7	R-2.3	R-2.8	R-3.3	R3.9	R-4.4	R-5.6	R-6.7
		Single Layer of Mineral Fiber									
	None	6.70	0.773	0.53	0.41	0.34	0.29	0.25	0.22	0.17	0.15
	R-1.8	1.06	0.48	0.37	0.31	0.27	0.23	0.21	0.19	0.15	0.13
	R-1.9	1.05	0.48	0.37	0.31	0.27	0.23	0.21	0.19	0.15	0.13
	R-2.3	0.920	0.45	0.36	0.30	0.26	0.23	0.20	0.18	0.15	0.13
	R-2.8	0.880	0.44	0.35	0.29	0.26	0.22	0.20	0.18	0.15	0.13
	R-3.3	0.835	0.43	0.34	0.28	0.25	0.22	0.20	0.18	0.15	0.13

Modify Appendix A, Section A9.2, as follows (I-P and SI units).

A9.2 Required Procedures. Two- or three-dimensional finite difference and finite volume computer models shall be an acceptable alternative method to calculating the thermal performance values for all assemblies and constructions listed below. The following procedures shall also be permitted to determine all alternative *U-factors*, *F-factors*, and *C-factors*.

a. Roofs
   1. *Roofs with insulation entirely above deck*: testing or series calculation method.
   2. *Metal building roofs*: testing, or for single-layer and double-layer systems, calculation method in Section A9.4.5.
   3. *Attic roofs*, wood joists: testing or parallel path calculation method.
   4. *Attic roofs*, steel joists: testing or parallel path calculation method using the insulation/framing layer adjustment factors in Table A9.2A or modified zone calculation method.
   5. *Attic roofs*, concrete joists: testing or parallel path calculation method if concrete is solid and uniform or isothermal planes calculation method if concrete has hollow sections.
   6. Other *attic roofs* and other *roofs*: testing or two-dimensional calculation method.

b. Above-Grade Walls
   1. *Mass walls*: testing or isothermal planes calculation method or two-dimensional calculation method. The parallel path calculation method is not acceptable.
   2. *Metal building walls*: testing, or for single-layer and double-layer systems, calculation method in Section A9.4.5.
   3. *Steel-framed walls*: testing or parallel path calculation method using the insulation/framing layer adjustment factors in Table A9.2B or the modified zone method.
   4. *Wood-framed walls*: testing or parallel path calculation method.
   5. Other *walls*: testing or two-dimensional calculation method.

c. Below-Grade Walls

1. *Mass walls*: testing or isothermal planes calculation method or two-dimensional calculation method. The parallel path calculation method is not acceptable.
2. *Other walls*: testing or two-dimensional calculation method.

d. Floors

1. *Mass floors*: testing or parallel path calculation method if concrete is solid and uniform or isothermal planes calculation method if concrete has hollow sections.
2. *Steel joist floors*: testing or modified zone calculation method.
3. *Wood joist floors*: testing or parallel path calculation method or isothermal planes calculation method.
4. Other *floors*: testing or two-dimensional calculation method.

e. Slab-on-Grade Floors
No testing or calculations allowed.

Add the following new subsection to Appendix A, Section A9.

I-P Units:

A9.4.5 Metal Building U-Factor Equations. For single-layer *metal building roof* and *wall* systems, the calculation procedure outlined in Section A9.4.5.1 shall be used to calculate the assembly *U-factor*. For double-layer *metal building roof* and *wall* systems, the calculation procedure outlined in Section A9.4.5.2 shall be used to calculate the assembly *U-factor*. The calculation procedures outlined in this section shall not be used for other *metal building roof* and *wall* systems.

A9.4.5.1 Single Layer. The U-factor of metal building roofs or walls that are insulated with a single layer of fiberglass insulation (see Figure A9.4A) shall be calculated using the procedure outlined in this section. The procedure assumes the insulation is compressed over the purlin or girt. There may also be a thermal spacer block present.

There are six steps in the calculation process:

Step 1—Characterize the thermal conductivity of the fiberglass,

Step 2—Determine the U-factor for the insulation in the cavity,

Step 3—Determine the U-factor over the structural framing member,

Step 4—Area weight the U-factors calculated in steps 2 and 3,

Step 5—Determine the U-factor from the finite element analysis results,

Step 6—Determine the U-factor for any continuous insulation if present.

Step 1—The thermal conductivity of the fiberglass batt insulation is represented by a thermal curve of the form in Equation A9.4-1:

$$k = A + B\rho + \frac{C}{\rho} \qquad \text{(A9.4-1)}$$

where

k = thermal conductivity, Btu/h·ft·°F

ρ = density, lb/ft^3

A = 0.014917

B = 0.0004377

C = 0.0056897

Step 2—Assume the fiberglass batt forms a parabolic profile defined by Equation A9.4-2:

$$Y = Y_o + (Y_m - Y_o)\left(\frac{X}{2}\right)\left(2 - \frac{X}{2}\right) \qquad \text{(A9.4-2)}$$

Determine the cavity U-factor (U_c) using Equation A9.4-3:

$$U_c = \frac{C}{\rho_o t_o} + \frac{B\rho_o t_o}{2Y_oY_m} + \left[A + \frac{B\rho_o t_o}{2Y_m}\right]\frac{1}{2(Y_m - Y_o)\sqrt{\dfrac{Y_m - Y_o}{Y_m}}}\ln\left(\frac{1 + \dfrac{Y_m - Y_o}{Y_m}}{1 - \dfrac{Y_m - Y_o}{Y_m}}\right)$$

(A9.4-3)

where

ρ_o = reference density of the fiberglass, lb/ft^3

t_o = reference thickness of the fiberglass, ft

The properties of fiberglass insulation are presented in Table A9.4F.

Include the thermal resistances of the interior (R_i) and exterior (R_e) air films to calculate the overall cavity U-factor (U_{co}) using Equation A9.4-4.

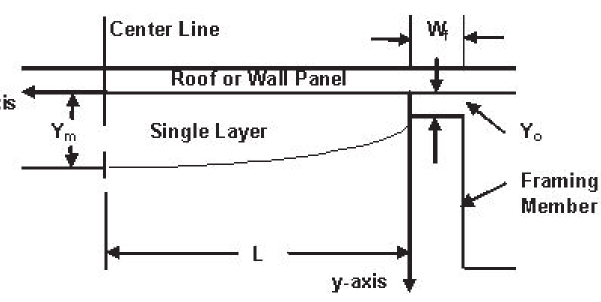

Figure A9.4A Geometry of Single-Layer Fiberglass Batt

where

X = distance from edge of purlin or girt, ft

Y = distance from edge of roof panel or wall panel, ft

L = length from edge of purlin or girt to centerline of cavity, ft

w_f = width of purlin or girt flange, ft

Y_o = distance between purlin or girt and the roof panel or wall panel, ft

Y_m = distance from edge of roof panel or wall panel at the cavity centerline, ft

$$U_{co} = \frac{1}{\frac{1}{U_c} + R_i + R_e} \qquad \text{(A9.4-4)}$$

TABLE A9.4F Fiberglass Reference Properties

R-Value, h·ft²·°F/Btu	Weight, lb/ft²	Density, lb/ft³	Thickness, ft
10	0.149	0.605	0.2458
11	0.168	0.630	0.2667
13	0.199	0.628	0.3167
16	0.243	0.634	0.3833
19	0.297	0.653	0.4542
25	0.427	0.742	0.5750
30	0.520	0.766	0.6792

Step 3—Determine the U-factor (U_{fo}) over the structural framing member. The variable Y_o represents the total combined thickness of the thermal spacer block and the compressed insulation. The density of the compressed insulation is determined by Equation A9.4-5:

$$\rho_c = \frac{\rho_o t_o}{t_c} \qquad \text{(A9.4-5)}$$

where

ρ_c = density of the compressed insulation over the framing member, lb/ft³

t_c = thickness of the compressed insulation over the framing member, ft

Determine the thermal resistance of the compressed insulation (R_c) using Equation A9.4-6:

$$R_c = \frac{t_c}{A + B\rho_c + C/\rho_c} \qquad \text{(A9.4-6)}$$

Determine the overall framing U-factor (U_{fo}) at the structural framing member including the air film resistances using Equation A9.4-7:

$$U_{fo} = \frac{1}{R_{TB} + R_c + R_i + R_e} \qquad \text{(A9.4-7)}$$

where

U_{fo} = U-factor over the structural framing member, Btu/h·ft²·°F

R_{TB} = R-value of the thermal spacer block, h·ft²·°F/Btu

R_c = R-value of the compressed insulation, h·ft²·°F/Btu

Step 4—Determine the overall area weighted U-factor for the entire system using Equation A9.4-8:

$$U_{es} = \frac{L \cdot U_{co} + (w_f/2) \cdot U_{fo}}{L + (w_f/2)} \qquad \text{(A9.4-8)}$$

where

U_{es} = area weighted U-factor for the entire system, Btu/h·ft²·°F

Step 5—Calculate the adjusted overall U-factor (U_{adj}) using Equation A9.4-9:

$$U_{adj} = \frac{1}{0.8676/U_{es} + 1.1423} \qquad \text{(A9.4-9)}$$

where

U_{adj} = adjusted overall U-factor represented by correlation with the finite element modeling, Btu/h·ft²·°F

Step 6—If there is any continuous insulation present, calculate the overall U-factor using Equation A9.4-10:

$$U = \frac{1}{\frac{1}{U_{adj}} + R_{ct}} \qquad \text{(A9.4-10)}$$

A9.4.5.2 Double Layers. The U-factor of metal building roofs that are insulated with double layers of fiberglass insulation (see Figure A9.4B) shall be calculated using the procedure outlined in this section. The procedure assumes the insulation is compressed over the purlin and there may be a thermal spacer block present.

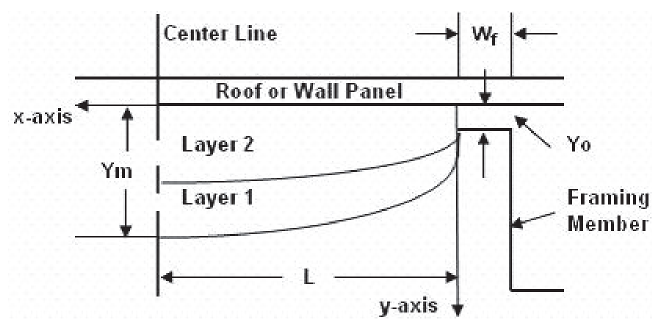

Figure A9.4B Geometry of Double Layers of Fiberglass Batts

where

X = distance from edge of purlin or girt, ft

Y = distance from edge of roof panel or wall panel, ft

L = length from edge of purlin or girt to centerline of cavity, ft

w_f = width of purlin or girt flange, ft

Y_o = distance between purlin or girt and the roof panel or wall panel, ft

Y_m = distance from edge of roof panel or wall panel at the cavity centerline, ft

There are six steps in the calculation process:

Step 1—Characterize the thermal conductivity of the fiberglass,

Step 2—Determine the U-factor for the insulation in the cavity,

Step 3—Determine the U-factor over the structural framing member,

Step 4—Area weight the U-factors calculated in steps 2 and 3,

Step 5—Determine the U-factor from the finite element analysis results,

Step 6—Determine the U-factor for any continuous insulation if present.

Step 1—The thermal conductivity of the fiberglass batt insulation is represented by a thermal curve of the form in Equation A9.4-11:

$$k = A + B\rho + \frac{C}{\rho} \qquad \text{(A9.4-11)}$$

where

k	=	thermal conductivity, Btu/h·ft·°F
ρ	=	density, lb/ft^3
A	=	0.014917
B	=	0.0004377
C	=	0.0056897

Step 2—Assume the double-layer fiberglass batt forms a parabolic profile defined by Equation A9.4-12:

$$Y = Y_o + (Y_m - Y_o)\left(\frac{X}{2}\right)\left(2 - \frac{X}{2}\right) \qquad \text{(A9.4-12)}$$

The presence of two layers of fiberglass adds complexity because each layer has distinct reference properties—see Table A9.4F. As the double layers are compressed, the thickness of each layer needs to be determined by considering that each layer achieves the same compressive force. Instead of having a closed-form analytical solution that predicts the U-factor for the cavity, the double-layer system requires that the parabolic profile be numerically integrated. The compression of the double-layer system is presented in Figure A9.4C.

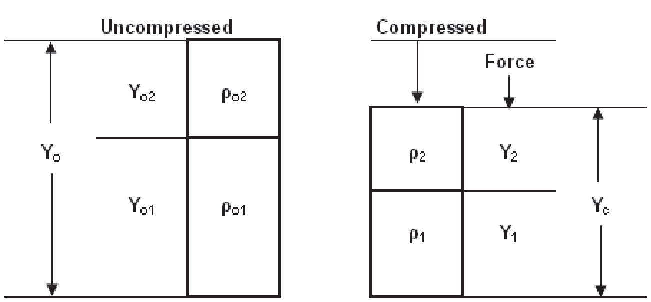

Figure A9.4C Compression of Double Layers of Fiberglass Insulation

The thickness of the second layer (Y_2) is described by Equation A9.4-13:

$$\left(\frac{Y_2}{Y_c}\right)^2 + \left[\frac{\rho o_1 W_1 + \rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2)(Y_c/12)} - 1\right]\left(\frac{Y_2}{Y_c}\right) - \frac{\rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c/12} = 0 \qquad \text{(A9.4-13)}$$

where

Y_c	=	compressed thickness of the double layers, ft
ρ_{o1}	=	reference density of first layer, lb/ft^3
ρ_{o2}	=	reference density of second layer, lb/ft^3
W_1	=	reference weight of first layer, lb/ft^2
W_2	=	reference weight of second layer, lb/ft^2

The solutions to Equation A9.4-13 are Equation A9.4-14a and A9.4-14b:

$$\frac{Y_{2,a}}{Y_c} = \left|\frac{-b + \sqrt{b^2 - 4ac}}{2a}\right| \qquad \text{(A9.4-14a)}$$

$$\frac{Y_{2,b}}{Y_c} = \left|\frac{-b - \sqrt{b^2 - 4ac}}{2a}\right| \qquad \text{(A9.4-14b)}$$

where

a = 1

$$b = \left[\frac{\rho o_1 W_1 + \rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2)(Y_c/12)} - 1\right]$$

$$c = \frac{\rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c/12}$$

Select the smaller value of $Y_{2,a}$ and $Y_{2,b}$ as Y_2. Y_1 shall be calculated as the difference between Y_c and Y_2. Next, the R-values for the two compressed layers of insulation shall be calculated and converted to a U-factor. This process shall be repeated along the entire profile and the results numerically integrated using maximum 0.04167 ft increments.

It is important to note that Equation A9.4-13 does not apply when the two layers of insulation are the same material. In this case, each compressed layer has the same thickness, which simplifies the U-factor calculations. The numerical integration still needs to be completed to determine the U_{co}.

Step 3—Determine the U-factor over the structural framing member. The variable (Y_o) represents the thickness of the thermal spacer block and the thickness of the compressed insulation. The density of the compressed insulation is determined by Equation A9.4-15:

$$\rho_c = \frac{\rho_o t_o}{t_c} \qquad \text{(A9.4-15)}$$

where

ρ_c = density of the compressed insulation over the framing member, lb/ft^3

t_c = thickness of the compressed insulation over the framing member, ft

The thermal resistance of the compressed insulation is determined by Equation A9.4-16:

$$R_c = \frac{t_c}{A + B\rho_c + C/\rho_c} \qquad \text{(A9.4-16)}$$

Determine the overall framing U-factor (U_{fo}) at the structural framing member including the air film resistances using Equation A9.4-17:

$$U_{f_o} = \frac{1}{R_{TB} + R_c + R_i + R_e} \qquad \text{(A9.4-17)}$$

where

U_{fo} = U-factor over the structural framing member, Btu/h·ft^2·°F

R_{TB} = R-value of the thermal spacer block, h·ft^2·°F/Btu

R_c = R-value of the compressed insulation, h·ft^2·°F/Btu

Step 4—Determine the overall area weighted U-factor for the entire system using Equation A9.4-18:

$$U_{es} = \frac{L \cdot U_{co} + (w_f/2) \cdot U_{fo}}{L + (w_f/2)} \qquad \text{(A9.4-18)}$$

where

U_{es} = area weighted U-factor for the entire system, Btu/h·ft^2·°F

Step 5—Calculate the adjusted overall U-factor (U_{adj}) using Equation A9.4-19:

$$U_{adj} = \frac{1}{0.8676/U_{es} + 1.1423} \qquad \text{(A9.4-19)}$$

where

U_{adj} = adjusted overall U-factor represented by correlation with the finite element modeling, Btu/h·ft^2·°F

Step 6—If there is any continuous insulation present, calculate the overall U-factor using Equation A9.4-20:

$$U_o = \frac{1}{\frac{1}{U_{ofe}} + R_{ci}} \qquad \text{(A9.4-20)}$$

SI Units:

A9.4.5 Metal Building U-Factor Equations. For single-layer *metal building roof* and *wall* systems, the calculation procedure outlined in Section A9.4.5.1 shall be used to calculate the assembly *U-factor.* For double-layer *metal building roof* and *wall* systems, the calculation procedure outlined in Section A9.4.5.2 shall be used to calculate the assembly *U-factor.* The calculation procedures outlined in this section shall not be used for other *metal building roof* and *wall* systems.

A9.4.5.1 Single Layer. The U-factor of metal building roofs or walls that are insulated with a single layer of fiberglass insulation (see Figure A9.4A) shall be calculated using the procedure outlined in this section. The procedure assumes the insulation is compressed over the purlin or girt. There may also be a thermal spacer block present.

There are six steps in the calculation process:

Step 1—Characterize the thermal conductivity of the fiberglass,

Step 2—Determine the U-factor for the insulation in the cavity,

Step 3—Determine the U-factor over the structural framing member,

Step 4—Area weight the U-factors calculated in steps 2 and 3,

Step 5—Determine the U-factor from the finite element analysis results,

Step 6—Determine the U-factor for any continuous insulation if present.

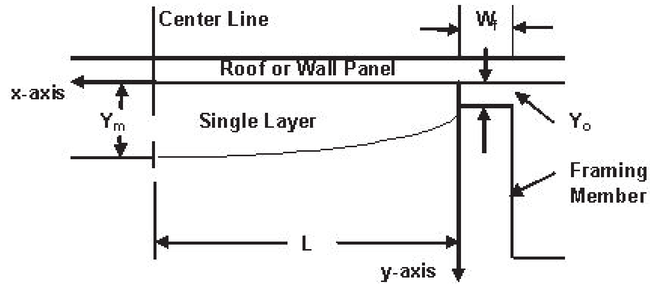

Figure A9.4A Geometry of Single-Layer Fiberglass Batt

where

X = distance from edge of purlin or girt, m

Y = distance from edge of roof panel or wall panel, m

L = length from edge of purlin or girt to centerline of cavity, m

w_f = width of purlin or girt flange, m

Y_o = distance between purlin or girt and the roof panel or wall panel, m

Y_m = distance from edge of roof panel or wall panel at the cavity centerline, m

Step 1—The thermal conductivity of the fiberglass batt insulation is represented by a thermal curve of the form in Equation A9.4-1:

$$k = A + B\rho + \frac{C}{\rho} \qquad \text{(A9.4-1)}$$

where

k = thermal conductivity, W/m·°C

ρ = density, kg/m^3

A = 0.00258168

B = 0.000047295

C = 0.157740033

Step 2—Assume the fiberglass batt forms a parabolic profile defined by Equation A9.4-2:

$$Y = Y_o + (Y_m - Y_o)\left(\frac{X}{2}\right)\left(2 - \frac{X}{2}\right) \quad \text{(A9.4-2)}$$

Determine the cavity U-factor (U_c) using Equation A9.4-3:

TABLE A9.4F Fiberglass Reference Properties

R-Value, m^2·°C/W	Weight, kg/m^2	Density, kg/m^3	Thickness, m
1.76	0.727	9.680	0.075
1.94	0.820	10.080	0.081
2.29	0.971	10.048	0.097
2.82	1.186	10.144	0.117
3.34	1.449	10.448	0.138
4.40	2.084	11.872	0.175
5.28	2.538	12.256	0.207

$$U_c = \frac{C}{\rho_o t_o} + \frac{B\rho_o t_o}{2Y_oY_m} + \left[A + \frac{B\rho_o t_o}{2Y_m}\right]\frac{1}{2(Y_m - Y_o)}\sqrt{\frac{Y_m - Y_o}{Y_m}}\ln\left(\frac{1 + \frac{Y_m - Y_o}{Y_m}}{1 - \frac{Y_m - Y_o}{Y_m}}\right) \quad \text{(A9.4-3)}$$

where

ρ_o = reference density of the fiberglass, kg/m^3

t_o = reference thickness of the fiberglass, m

The properties of fiberglass insulation are presented in Table A9.4F.

Include the thermal resistances of the interior (R_i) and exterior (R_e) air films to calculate the overall cavity U-factor (U_{co}) using Equation A9.4-4:

$$U_{co} = \frac{1}{\frac{1}{U_c} + R_i + R_e} \quad \text{(A9.4-4)}$$

Step 3—Determine the U-factor (U_{fo}) over the structural framing member. The variable Y_o represents the total combined thickness of the thermal spacer block and the compressed insulation. The density of the compressed insulation is determined by Equation A9.4-5:

$$\rho_c = \frac{\rho_o t_o}{t_c} \quad \text{(A9.4-5)}$$

where

ρ_c = density of the compressed insulation over the framing member, kg/m^3

t_c = thickness of the compressed insulation over the framing member, m

Determine the thermal resistance of the compressed insulation (R_c) using Equation A9.4-6:

$$R_c = \frac{t_c}{A + B\rho_c + C/\rho_c} \quad \text{(A9.4-6)}$$

Determine the overall framing U-factor (U_{fo}) at the structural framing member including the air film resistances using Equation A9.4-7:

$$U_{fo} = \frac{1}{R_{TB} + R_c + R_i + R_e} \quad \text{(A9.4-7)}$$

where

U_{fo} = U-factor over the structural framing member, W/m^2·°C

R_{TB} = R-value of the thermal spacer block, m^2·°C/W

R_c = R-value of the compressed insulation, m^2·°C/W

Step 4—Determine the overall area weighted U-factor for the entire system using Equation A9.4-8:

$$U_{es} = \frac{L \cdot U_{co} + (w_f/2) \cdot U_{fo}}{L + (w_f/2)} \quad \text{(A9.4-8)}$$

where

U_{es} = area weighted U-factor for the entire system, W/m^2·°C

w_f = width of purlin or girt flange, m

Step 5—Calculate the adjusted overall U-factor (U_{adj}) using Equation A9.4-9:

$$U_{adj} = \frac{1}{0.8676/U_{es} + 0.2012} \quad \text{(A9.4-9)}$$

where

U_{adj} = adjusted overall U-factor represented by correlation with the finite element modeling, W/m^2·°C

Step 6—If there is any continuous insulation present, calculate the overall U-factor using Equation A9.4-10:

$$U = \frac{1}{\frac{1}{U_{ofe}} + R_{ci}} \quad \text{(A9.4-10)}$$

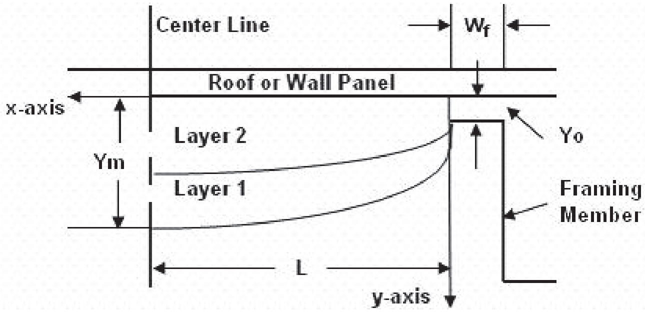

Figure A9.4B Geometry of Double Layers of Fiberglass Batts

where

X	=	distance from edge of purlin or girt, m
Y	=	distance from edge of roof panel or wall panel, m
L	=	length from edge of purlin or girt to centerline of cavity, m
w_f	=	width of purlin or girt flange, m
Y_o	=	distance between purlin or girt and the roof panel or wall panel, m
Y_m	=	distance from edge of roof panel or wall panel at the cavity centerline, m

A9.4.5.2 Double Layers. The U-factor of metal building roofs that are insulated with double layers of fiberglass insulation (see Figure A9.4B) shall be calculated using the procedure outlined in this section. The procedure assumes the insulation is compressed over the purlin and there may be a thermal spacer block present.

There are six steps in the calculation process:

Step 1—Characterize the thermal conductivity of the fiberglass,

Step 2—Determine the U-factor for the insulation in the cavity,

Step 3—Determine the U-factor over the structural framing member,

Step 4—Area weight the U-factors calculated in steps 2 and 3,

Step 5—Determine the U-factor from the finite element analysis results,

Step 6—Determine the U-factor for any continuous insulation if present.

Step 1—The thermal conductivity of the fiberglass batt insulation is represented by a thermal curve of the form in Equation A9.4-11:

$$k = A + B\rho + \frac{C}{\rho} \qquad \text{(A9.4-11)}$$

where

k	=	thermal conductivity, W/m·°C
ρ	=	density, kg/m^3
A	=	0.0258168
B	=	0.000047295
C	=	0.157740033

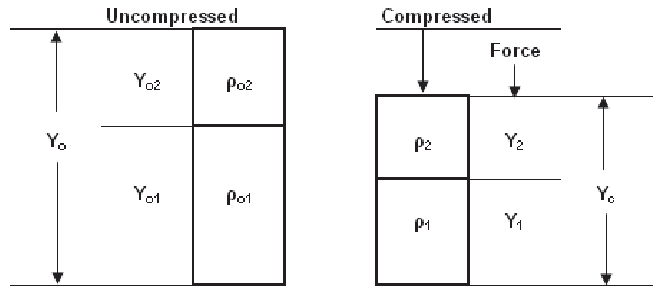

Figure A9.4C Compression of Double Layers of Fiberglass Insulation

Step 2—Assume the double-layer fiberglass batt forms a parabolic profile defined by Equation A9.4-12:

$$Y = Y_o + (Y_m - Y_o)\left(\frac{X}{2}\right)\left(2 - \frac{X}{2}\right) \qquad \text{(A9.4-12)}$$

The presence of two layers of fiberglass adds complexity because each layer has distinct reference properties—see Table A9.4F. As the double layers are compressed, the thickness of each layer needs to be determined by considering that the each layer achieves the same compressive force. Instead of having a closed-form analytical solution that predicts the U-factor for the cavity, the double-layer system requires that the parabolic profile be numerically integrated. The compression of the double-layer system is presented in Figure A9.4C.

The thickness of the second layer (Y_2) is described by Equation A9.4-13:

$$\left(\frac{Y_2}{Y_c}\right)^2 + \left[\frac{\rho o_1 W_1 + \rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c} - 1\right]\left(\frac{Y_2}{Y_c}\right) - \frac{\rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c} = 0 \qquad \text{(A9.4-13)}$$

where

Y_c	=	compressed thickness of the double layers, m
ρ_{o1}	=	reference density of first layer, kg/m^3
ρ_{o2}	=	reference density of second layer, kg/m^3
W_1	=	reference weight of first layer, kg/m^2
W_2	=	reference weight of second layer, kg/m^2

The solutions to Equation A9.4-13 are Equation A9.4-14a and A9.4-14b:

$$\frac{Y_{2,a}}{Y_c} = \left|\frac{-b + \sqrt{b^2 - 4ac}}{2a}\right| \qquad \text{(A9.4-14a)}$$

$$\frac{Y_{2,b}}{Y_c} = \left| \frac{-b - \sqrt{b^2 - 4ac}}{2a} \right| \qquad \text{(A9.4-14b)}$$

where

a = 1

b = $\left[\frac{\rho o_1 W_1 + \rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c} - 1 \right]$

c = $\frac{\rho o_2 W_2}{(\rho o_1^2 - \rho o_2^2) Y_c}$

Select the smaller value of $Y_{2,a}$ and $Y_{2,b}$ as Y_2. Y_1 shall be calculated as the difference between Y_c and Y_2. Next, the R-values for the two compressed layers of insulation shall be calculated and converted to a U-factor. This process shall be repeated along the entire profile and the results numerically integrated using maximum 0.0.127 m increments.

In Appendix B, delete the existing Table B-1, U.S. Climate Zones, in its entirety and replace it with the following.

It is important to note that Equation A9.4-13 does not apply when the two layers of insulation are the same material. In this case, each compressed layer has the same thickness, which simplifies the U-factor calculations. The numerical integration still needs to be completed to determine the U_{co}.

Step 3—Determine the U-factor over the structural framing member. The variable Y_o represents the thickness of the thermal spacer block and the thickness of the compressed insulation. The density of the compressed insulation is determined by Equation A9.4-15:

$$\rho_c = \frac{\rho_o t_o}{t_c} \qquad \text{(A9.4-15)}$$

where

ρ_c = density of the compressed insulation over the framing member, kg/m^3

t_c = thickness of the compressed insulation over the framing member, m

The thermal resistance of the compressed insulation is determined by Equation A9.4-16:

$$R_c = \frac{t_c}{A + B\rho_c + C/\rho_c} \qquad \text{(A9.4-16)}$$

Determine the overall framing U-factor (U_{fo}) at the structural framing member including the air film resistances using Equation A9.4-17:

$$U_{fo} = \frac{1}{R_{TB} + R_c + R_i + R_e} \qquad \text{(A9.4-17)}$$

where

U_{fo} = U-factor over the structural framing member, W/m^2·°C

R_{TB} = R-value of the thermal spacer block, m^2·°C/W

R_c = R-value of the compressed insulation, m^2·°C/W

Step 4—Determine the overall area weighted U-factor for the entire system using Equation A9.4-18:

$$U_{es} = \frac{L \cdot U_{co} + (w_f/2) \cdot U_{fo}}{L + (w_f/2)} \qquad \text{(A9.4-18)}$$

where

U_{es} = area weighted U-factor for the entire system, W/m^2·°C

Step 5—Calculate the adjusted overall U-factor (U_{adj}) using Equation A9.4-19:

$$U_{adj} = \frac{1}{0.8676/U_{es} + 0.2012} \qquad \text{(A9.4-19)}$$

where

U_{adj} = adjusted overall U-factor represented by correlation with the finite element modeling, W/m^2·°C

Step 6—If there is any continuous insulation present, calculate the overall U-factor using Equation A9.4-20:

$$U_o = \frac{1}{\frac{1}{U_{ofe}} + R_{ci}} \qquad \text{(A9.4-20)}$$

TABLE B-1 U.S. Climate Zones

KEY: A—Moist, B—Dry, C—Marine. Absence of moisture designation indicates moisture regime is irrelevant. An asterisk (*) indicates a Warm-Humid location.

U.S. STATE
ALABAMA
3A Autauga*
2A Baldwin*
3A Barbour*
3A Bibb
3A Blount
3A Bullock*
3A Butler*
3A Calhoun
3A Chambers
3A Cherokee
3A Chilton
3A Choctaw*
3A Clarke*
3A Clay
3A Cleburne
3A Coffee*
3A Colbert
3A Conecuh*
3A Coosa
3A Covington*
3A Crenshaw*
3A Cullman
3A Dale*
3A Dallas*
3A DeKalb
3A Elmore*
3A Escambia*
3A Etowah
3A Fayette
3A Franklin
3A Geneva*
3A Greene
3A Hale
3A Henry*
3A Houston*
3A Jackson
3A Jefferson
3A Lamar
3A Lauderdale
3A Lawrence
3A Lee
3A Limestone
3A Lowndes*
3A Macon*
3A Madison
3A Marengo*
3A Marion
3A Marshall

U.S. STATE
2A Mobile*
3A Monroe*
3A Montgomery*
3A Morgan
3A Perry*
3A Pickens
3A Pike*
3A Randolph
3A Russell*
3A Shelby
3A St. Clair
3A Sumter
3A Talladega
3A Tallapoosa
3A Tuscaloosa
3A Walker
3A Washington*
3A Wilcox*
3A Winston
ALASKA
7 Aleutians, East
7 Aleutians, West
7 Anchorage
8 Bethel
7 Bristol Bay
7 Denali
8 Dillingham
8 Fairbanks
8 North Star
7 Haines
7 Juneau
7 Kenai Peninsula
7 Ketchikan Gateway
7 Kodiak Island
7 Lake and Peninsula
7 Matanuska-Susitna
8 Nome
8 North Slope
8 Northwest Arctic
7 Prince of Wales-Outer Ketchikan
7 Sitka

U.S. STATE
7 Skagway-Hoonah-Angoon
8 Southeast Fairbanks
7 Valdez-Cordova
8 Wade Hampton
7 Wrangell-Petersburg
7 Yakutat
8 Yukon-Koyukuk
ARIZONA
5B Apache
3B Cochise
5B Coconino
4B Gila
3B Graham
3B Greenlee
2B La Paz
2B Maricopa
3B Mohave
5B Navajo
2B Pima
2B Pinal
3B Santa Cruz
4B Yavapai
2B Yuma
ARKANSAS
3A Arkansas
3A Ashley
4A Baxter
4A Benton
4A Boone
3A Bradley
3A Calhoun
4A Carroll
3A Chicot
3A Clark
3A Clay
3A Cleburne
3A Cleveland
3A Columbia*
3A Conway
3A Craighead
3A Crawford

U.S. STATE
3A Crittenden
3A Cross
3A Dallas
3A Desha
3A Drew
3A Faulkner
3A Franklin
4A Fulton
3A Garland
3A Grant
3A Greene
3A Hempstead*
3A Hot Spring
3A Howard
3A Independence
4A Izard
3A Jackson
3A Jefferson
3A Johnson
3A Lafayette*
3A Lawrence
3A Lee
3A Lincoln
3A Little River*
3A Logan
3A Lonoke
4A Madison
4A Marion
3A Miller*
3A Mississippi
3A Monroe
3A Montgomery
3A Nevada
4A Newton
3A Ouachita
3A Perry
3A Phillips
3A Pike
3A Poinsett
3A Polk
3A Pope
3A Prairie
3A Pulaski

U.S. STATE
3A Randolph
3A Saline
3A Scott
4A Searcy
3A Sebastian
3A Sevier*
3A Sharp
3A St. Francis
4A Stone
3A Union*
3A Van Buren
4A Washington
3A White
3A Woodruff
3A Yell
CALIFORNIA
3C Alameda
6B Alpine
4B Amador
3B Butte
4B Calaveras
3B Colusa
3B Contra Costa
4C Del Norte
4B El Dorado
3B Fresno
3B Glenn
4C Humboldt
2B Imperial
4B Inyo
3B Kern
3B Kings
4B Lake
5B Lassen
3B Los Angeles
3B Madera
3C Marin
4B Mariposa
3C Mendocino
3B Merced
5B Modoc
6B Mono
3C Monterey

U.S. STATE
3C Napa
5B Nevada
3B Orange
3B Placer
5B Plumas
3B Riverside
3B Sacramento
3C San Benito
3B San Bernardino
3B San Diego
3C San Francisco
3B San Joaquin
3C San Luis Obispo
3C San Mateo
3C Santa Barbara
3C Santa Clara
3C Santa Cruz
3B Shasta
5B Sierra
5B Siskiyou
3B Solano
3C Sonoma
3B Stanislaus
3B Sutter
3B Tehama
4B Trinity
3B Tulare
4B Tuolumne
3C Ventura
3B Yolo
3B Yuba
COLORADO
5B Adams
6B Alamosa
5B Arapahoe
6B Archuleta
4B Baca
5B Bent
5B Boulder
6B Chaffee
5B Cheyenne
7 Clear Creek
6B Conejos

U.S. STATE
6B Costilla
5B Crowley
6B Custer
5B Delta
5B Denver
6B Dolores
5B Douglas
6B Eagle
5B Elbert
5B El Paso
5B Fremont
5B Garfield
5B Gilpin
7 Grand
7 Gunnison
7 Hinsdale
5B Huerfano
7 Jackson
5B Jefferson
5B Kiowa
5B Kit Carson
7 Lake
5B La Plata
5B Larimer
4B Las Animas
5B Lincoln
5B Logan
5B Mesa
7 Mineral
6B Moffat
5B Montezuma
5B Montrose
5B Morgan
4B Otero
6B Ouray
7 Park
5B Phillips
7 Pitkin
5B Prowers
5B Pueblo
6B Rio Blanco
7 Rio Grande
7 Routt

U.S. STATE
6B Saguache
7 San Juan
6B San Miguel
5B Sedgwick
7 Summit
5B Teller
5B Washington
5B Weld
5B Yuma
CONNECTICUT
5A (all)
DELAWARE
4A (all)
DISTRICT OF COLUMBIA
4A (all)
FLORIDA
2A Alachua*
2A Baker*
2A Bay*
2A Bradford*
2A Brevard*
1A Broward*
2A Calhoun*
2A Charlotte*
2A Citrus*
2A Clay*
2A Collier*
2A Columbia*
2A DeSoto*
2A Dixie*
2A Duval*
2A Escambia*
2A Flagler*
2A Franklin*
2A Gadsden*
2A Gilchrist*
2A Glades*
2A Gulf*
2A Hamilton*
2A Hardee*
2A Hendry*
2A Hernando*

U.S. STATE
2A Highlands*
2A Hillsborough*
2A Holmes*
2A Indian River*
2A Jackson*
2A Jefferson*
2A Lafayette*
2A Lake*
2A Lee*
2A Leon*
2A Levy*
2A Liberty*
2A Madison*
2A Manatee*
2A Marion*
2A Martin*
1A Miami-Dade*
1A Monroe*
2A Nassau*
2A Okaloosa*
2A Okeechobee*
2A Orange*
2A Osceola*
2A Palm Beach*
2A Pasco*
2A Pinellas*
2A Polk*
2A Putnam*
2A Santa Rosa*
2A Sarasota*
2A Seminole*
2A St. Johns*
2A St. Lucie*
2A Sumter*
2A Suwannee*
2A Taylor*
2A Union*
2A Volusia*
2A Wakulla*
2A Walton*
2A Washington*
GEORGIA
2A Appling*

U.S. STATE
2A Atkinson*
2A Bacon*
2A Baker*
3A Baldwin
4A Banks
3A Barrow
3A Bartow
3A Ben Hill*
2A Berrien*
3A Bibb
3A Bleckley*
2A Brantley*
2A Brooks*
2A Bryan*
3A Bulloch*
3A Burke
3A Butts
3A Calhoun*
2A Camden*
3A Candler*
3A Carroll
4A Catoosa
2A Charlton*
2A Chatham*
3A Chattahoochee*
4A Chattooga
3A Cherokee
3A Clarke
3A Clay*
3A Clayton
2A Clinch*
3A Cobb
3A Coffee*
2A Colquitt*
3A Columbia
2A Cook*
3A Coweta
3A Crawford
3A Crisp*
4A Dade
4A Dawson
2A Decatur*
3A DeKalb

U.S. STATE
3A Dodge*
3A Dooly*
3A Dougherty*
3A Douglas
3A Early*
2A Echols*
2A Effingham*
3A Elbert
3A Emanuel*
2A Evans*
4A Fannin
3A Fayette
4A Floyd
3A Forsyth
4A Franklin
3A Fulton
4A Gilmer
3A Glascock
2A Glynn*
4A Gordon
2A Grady*
3A Greene
3A Gwinnett
4A Habersham
4A Hall
3A Hancock
3A Haralson
3A Harris
3A Hart
3A Heard
3A Henry
3A Houston*
3A Irwin*
3A Jackson
3A Jasper
2A Jeff Davis*
3A Jefferson
3A Jenkins*
3A Johnson*
3A Jones
3A Lamar
2A Lanier*
3A Laurens*

U.S. STATE
3A Lee*
2A Liberty*
3A Lincoln
2A Long*
2A Lowndes*
4A Lumpkin
3A Macon*
3A Madison
3A Marion*
3A McDuffie
2A McIntosh*
3A Meriwether
2A Miller*
2A Mitchell*
3A Monroe
3A Montgomery*
3A Morgan
4A Murray
3A Muscogee
3A Newton
3A Oconee
3A Oglethorpe
3A Paulding
3A Peach*
4A Pickens
2A Pierce*
3A Pike
3A Polk
3A Pulaski*
3A Putnam
3A Quitman*
4A Rabun
3A Randolph*
3A Richmond
3A Rockdale
3A Schley*
3A Screven*
2A Seminole*
3A Spalding
4A Stephens
3A Stewart*
3A Sumter*
3A Talbot

U.S. STATE
3A Taliaferro
2A Tattnall*
3A Taylor*
3A Telfair*
3A Terrell*
2A Thomas*
3A Tift*
2A Toombs*
4A Towns
3A Treutlen*
3A Troup
3A Turner*
3A Twiggs*
4A Union
3A Upson
4A Walker
3A Walton
2A Ware*
3A Warren
3A Washington
2A Wayne*
3A Webster*
3A Wheeler*
4A White
4A Whitfield
3A Wilcox*
3A Wilkes
3A Wilkinson
3A Worth*
HAWAII
1A (all)*
IDAHO
5B Ada
6B Adams
6B Bannock
6B Bear Lake
5B Benewah
6B Bingham
6B Blaine
6B Boise
6B Bonner
6B Bonneville
6B Boundary

U.S. STATE
6B Butte
6B Camas
5B Canyon
6B Caribou
5B Cassia
6B Clark
5B Clearwater
6B Custer
5B Elmore
6B Franklin
6B Fremont
5B Gem
5B Gooding
5B Idaho
6B Jefferson
5B Jerome
5B Kootenai
5B Latah
6B Lemhi
5B Lewis
5B Lincoln
6B Madison
5B Minidoka
5B Nez Perce
6B Oneida
5B Owyhee
5B Payette
5B Power
5B Shoshone
6B Teton
5B Twin Falls
6B Valley
5B Washington
ILLINOIS
5A Adams
4A Alexander
4A Bond
5A Boone
5A Brown
5A Bureau
5A Calhoun
5A Carroll
5A Cass

U.S. STATE
5A Champaign
4A Christian
5A Clark
4A Clay
4A Clinton
5A Coles
5A Cook
4A Crawford
5A Cumberland
5A DeKalb
5A De Witt
5A Douglas
5A DuPage
5A Edgar
4A Edwards
4A Effingham
4A Fayette
5A Ford
4A Franklin
5A Fulton
4A Gallatin
5A Greene
5A Grundy
4A Hamilton
5A Hancock
4A Hardin
5A Henderson
5A Henry
5A Iroquois
4A Jackson
4A Jasper
4A Jefferson
5A Jersey
5A Jo Daviess
4A Johnson
5A Kane
5A Kankakee
5A Kendall
5A Knox
5A Lake
5A La Salle
4A Lawrence
5A Lee

U.S. STATE
5A Livingston
5A Logan
5A Macon
4A Macoupin
4A Madison
4A Marion
5A Marshall
5A Mason
4A Massac
5A McDonough
5A McHenry
5A McLean
5A Menard
5A Mercer
4A Monroe
4A Montgomery
5A Morgan
5A Moultrie
5A Ogle
5A Peoria
4A Perry
5A Piatt
5A Pike
4A Pope
4A Pulaski
5A Putnam
4A Randolph
4A Richland
5A Rock Island
4A Saline
5A Sangamon
5A Schuyler
5A Scott
4A Shelby
5A Stark
4A St. Clair
5A Stephenson
5A Tazewell
4A Union
5A Vermilion
4A Wabash
5A Warren
4A Washington

U.S. STATE
4A Wayne
4A White
5A Whiteside
5A Will
4A Williamson
5A Winnebago
5A Woodford
INDIANA
5A Adams
5A Allen
5A Bartholomew
5A Benton
5A Blackford
5A Boone
4A Brown
5A Carroll
5A Cass
4A Clark
5A Clay
5A Clinton
4A Crawford
4A Daviess
4A Dearborn
5A Decatur
5A De Kalb
5A Delaware
4A Dubois
5A Elkhart
5A Fayette
4A Floyd
5A Fountain
5A Franklin
5A Fulton
4A Gibson
5A Grant
4A Greene
5A Hamilton
5A Hancock
4A Harrison
5A Hendricks
5A Henry
5A Howard
5A Huntington

U.S. STATE
4A Jackson
5A Jasper
5A Jay
4A Jefferson
4A Jennings
5A Johnson
4A Knox
5A Kosciusko
5A Lagrange
5A Lake
5A La Porte
4A Lawrence
5A Madison
5A Marion
5A Marshall
4A Martin
5A Miami
4A Monroe
5A Montgomery
5A Morgan
5A Newton
5A Noble
4A Ohio
4A Orange
5A Owen
5A Parke
4A Perry
4A Pike
5A Porter
4A Posey
5A Pulaski
5A Putnam
5A Randolph
4A Ripley
5A Rush
4A Scott
5A Shelby
4A Spencer
5A Starke
5A Steuben
5A St. Joseph
4A Sullivan
4A Switzerland

U.S. STATE
5A Tippecanoe
5A Tipton
5A Union
4A Vanderburgh
5A Vermillion
5A Vigo
5A Wabash
5A Warren
4A Warrick
4A Washington
5A Wayne
5A Wells
5A White
5A Whitley
IOWA
5A Adair
5A Adams
6A Allamakee
5A Appanoose
5A Audubon
5A Benton
6A Black Hawk
5A Boone
6A Bremer
6A Buchanan
6A Buena Vista
6A Butler
6A Calhoun
5A Carroll
5A Cass
5A Cedar
6A Cerro Gordo
6A Cherokee
6A Chickasaw
5A Clarke
6A Clay
6A Clayton
5A Clinton
5A Crawford
5A Dallas
5A Davis
5A Decatur
6A Delaware

U.S. STATE
5A Des Moines
6A Dickinson
5A Dubuque
6A Emmet
6A Fayette
6A Floyd
6A Franklin
5A Fremont
5A Greene
6A Grundy
5A Guthrie
6A Hamilton
6A Hancock
6A Hardin
5A Harrison
5A Henry
6A Howard
6A Humboldt
6A Ida
5A Iowa
5A Jackson
5A Jasper
5A Jefferson
5A Johnson
5A Jones
5A Keokuk
6A Kossuth
5A Lee
5A Linn
5A Louisa
5A Lucas
6A Lyon
5A Madison
5A Mahaska
5A Marion
5A Marshall
5A Mills
6A Mitchell
5A Monona
5A Monroe
5A Montgomery
5A Muscatine
6A O'Brien

U.S. STATE
6A Osceola
5A Page
6A Palo Alto
6A Plymouth
6A Pocahontas
5A Polk
5A Pottawattamie
5A Poweshiek
5A Ringgold
6A Sac
5A Scott
5A Shelby
6A Sioux
5A Story
5A Tama
5A Taylor
5A Union
5A Van Buren
5A Wapello
5A Warren
5A Washington
5A Wayne
6A Webster
6A Winnebago
6A Winneshiek
5A Woodbury
6A Worth
6A Wright
KANSAS
4A Allen
4A Anderson
4A Atchison
4A Barber
4A Barton
4A Bourbon
4A Brown
4A Butler
4A Chase
4A Chautauqua
4A Cherokee
5A Cheyenne
4A Clark
4A Clay

U.S. STATE
5A Cloud
4A Coffey
4A Comanche
4A Cowley
4A Crawford
5A Decatur
4A Dickinson
4A Doniphan
4A Douglas
4A Edwards
4A Elk
5A Ellis
4A Ellsworth
4A Finney
4A Ford
4A Franklin
4A Geary
5A Gove
5A Graham
4A Grant
4A Gray
5A Greeley
4A Greenwood
5A Hamilton
4A Harper
4A Harvey
4A Haskell
4A Hodgeman
4A Jackson
4A Jefferson
5A Jewell
4A Johnson
4A Kearny
4A Kingman
4A Kiowa
4A Labette
5A Lane
4A Leavenworth
4A Lincoln
4A Linn
5A Logan
4A Lyon
4A Marion

U.S. STATE
4A Marshall
4A McPherson
4A Meade
4A Miami
5A Mitchell
4A Montgomery
4A Morris
4A Morton
4A Nemaha
4A Neosho
5A Ness
5A Norton
4A Osage
5A Osborne
4A Ottawa
4A Pawnee
5A Phillips
4A Pottawatomie
4A Pratt
5A Rawlins
4A Reno
5A Republic
4A Rice
4A Riley
5A Rooks
4A Rush
4A Russell
4A Saline
5A Scott
4A Sedgwick
4A Seward
4A Shawnee
5A Sheridan
5A Sherman
5A Smith
4A Stafford
4A Stanton
4A Stevens
4A Sumner
5A Thomas
5A Trego
4A Wabaunsee
5A Wallace

U.S. STATE
4A Washington
5A Wichita
4A Wilson
4A Woodson
4A Wyandotte
KENTUCKY
4A (all)
LOUISIANA
2A Acadia*
2A Allen*
2A Ascension*
2A Assumption*
2A Avoyelles*
2A Beauregard*
3A Bienville*
3A Bossier*
3A Caddo*
2A Calcasieu*
3A Caldwell*
2A Cameron*
3A Catahoula*
3A Claiborne*
3A Concordia*
3A De Soto*
2A East Baton Rouge*
3A East Carroll
2A East Feliciana*
2A Evangeline*
3A Franklin*
3A Grant*
2A Iberia*
2A Iberville*
3A Jackson*
2A Jefferson*
2A Jefferson Davis*
2A Lafayette*
2A Lafourche*
3A La Salle*
3A Lincoln*
2A Livingston*
3A Madison*
3A Morehouse
3A Natchitoches*

U.S. STATE
2A Orleans*
3A Ouachita*
2A Plaquemines*
2A Pointe Coupee*
2A Rapides*
3A Red River*
3A Richland*
3A Sabine*
2A St. Bernard*
2A St. Charles*
2A St. Helena*
2A St. James*
2A St. John the Baptist*
2A St. Landry*
2A St. Martin*
2A St. Mary*
2A St. Tammany*
2A Tangipahoa*
3A Tensas*
2A Terrebonne*
3A Union*
2A Vermilion*
3A Vernon*
2A Washington*
3A Webster*
2A West Baton Rouge*
3A West Carroll
2A West Feliciana*
3A Winn*
MAINE
6A Androscoggin
7 Aroostook
6A Cumberland
6A Franklin
6A Hancock
6A Kennebec
6A Knox
6A Lincoln
6A Oxford
6A Penobscot

U.S. STATE
6A Piscataquis
6A Sagadahoc
6A Somerset
6A Waldo
6A Washington
6A York
MARYLAND
4A Allegany
4A Anne Arundel
4A Baltimore
4A Baltimore (city)
4A Calvert
4A Caroline
4A Carroll
4A Cecil
4A Charles
4A Dorchester
4A Frederick
5A Garrett
4A Harford
4A Howard
4A Kent
4A Montgomery
4A Prince George's
4A Queen Anne's
4A Somerset
4A St. Mary's
4A Talbot
4A Washington
4A Wicomico
4A Worcester
MASSACHUSETTS
5A (all)
MICHIGAN
6A Alcona
6A Alger
5A Allegan
6A Alpena
6A Antrim
6A Arenac
7 Baraga
5A Barry
5A Bay

U.S. STATE
6A Benzie
5A Berrien
5A Branch
5A Calhoun
5A Cass
6A Charlevoix
6A Cheboygan
7 Chippewa
6A Clare
5A Clinton
6A Crawford
6A Delta
6A Dickinson
5A Eaton
6A Emmet
5A Genesee
6A Gladwin
7 Gogebic
6A Grand Traverse
5A Gratiot
5A Hillsdale
7 Houghton
6A Huron
5A Ingham
5A Ionia
6A Iosco
7 Iron
6A Isabella
5A Jackson
5A Kalamazoo
6A Kalkaska
5A Kent
7 Keweenaw
6A Lake
5A Lapeer
6A Leelanau
5A Lenawee
5A Livingston
7 Luce
7 Mackinac
5A Macomb
6A Manistee
6A Marquette

U.S. STATE
6A Mason
6A Mecosta
6A Menominee
5A Midland
6A Missaukee
5A Monroe
5A Montcalm
6A Montmorency
5A Muskegon
6A Newaygo
5A Oakland
6A Oceana
6A Ogemaw
7 Ontonagon
6A Osceola
6A Oscoda
6A Otsego
5A Ottawa
6A Presque Isle
6A Roscommon
5A Saginaw
6A Sanilac
7 Schoolcraft
5A Shiawassee
5A St. Clair
5A St. Joseph
5A Tuscola
5A Van Buren
5A Washtenaw
5A Wayne
6A Wexford
MINNESOTA
7 Aitkin
6A Anoka
7 Becker
7 Beltrami
6A Benton
6A Big Stone
6A Blue Earth
6A Brown
7 Carlton
6A Carver
7 Cass

U.S. STATE
6A Chippewa
6A Chisago
7 Clay
7 Clearwater
7 Cook
6A Cottonwood
7 Crow Wing
6A Dakota
6A Dodge
6A Douglas
6A Faribault
6A Fillmore
6A Freeborn
6A Goodhue
7 Grant
6A Hennepin
6A Houston
7 Hubbard
6A Isanti
7 Itasca
6A Jackson
7 Kanabec
6A Kandiyohi
7 Kittson
7 Koochiching
6A Lac qui Parle
7 Lake
7 Lake of the Woods
6A Le Sueur
6A Lincoln
6A Lyon
7 Mahnomen
7 Marshall
6A Martin
6A McLeod
6A Meeker
7 Mille Lacs
6A Morrison
6A Mower
6A Murray
6A Nicollet
6A Nobles
7 Norman

U.S. STATE
6A Olmsted
7 Otter Tail
7 Pennington
7 Pine
6A Pipestone
7 Polk
6A Pope
6A Ramsey
7 Red Lake
6A Redwood
6A Renville
6A Rice
6A Rock
7 Roseau
6A Scott
6A Sherburne
6A Sibley
6A Stearns
6A Steele
6A Stevens
7 St. Louis
6A Swift
6A Todd
6A Traverse
6A Wabasha
7 Wadena
6A Waseca
6A Washington
6A Watonwan
7 Wilkin
6A Winona
6A Wright
6A Yellow Medicine
MISSISSIPPI
3A Adams*
3A Alcorn
3A Amite*
3A Attala
3A Benton
3A Bolivar
3A Calhoun
3A Carroll
3A Chickasaw

U.S. STATE
3A Choctaw
3A Claiborne*
3A Clarke
3A Clay
3A Coahoma
3A Copiah*
3A Covington*
3A DeSoto
3A Forrest*
3A Franklin*
3A George*
3A Greene*
3A Grenada
2A Hancock*
2A Harrison*
3A Hinds*
3A Holmes
3A Humphreys
3A Issaquena
3A Itawamba
2A Jackson*
3A Jasper
3A Jefferson*
3A Jefferson Davis*
3A Jones*
3A Kemper
3A Lafayette
3A Lamar*
3A Lauderdale
3A Lawrence*
3A Leake
3A Lee
3A Leflore
3A Lincoln*
3A Lowndes
3A Madison
3A Marion*
3A Marshall
3A Monroe
3A Montgomery
3A Neshoba
3A Newton
3A Noxubee

U.S. STATE
3A Oktibbeha
3A Panola
2A Pearl River*
3A Perry*
3A Pike*
3A Pontotoc
3A Prentiss
3A Quitman
3A Rankin*
3A Scott
3A Sharkey
3A Simpson*
3A Smith*
2A Stone*
3A Sunflower
3A Tallahatchie
3A Tate
3A Tippah
3A Tishomingo
3A Tunica
3A Union
3A Walthall*
3A Warren*
3A Washington
3A Wayne*
3A Webster
3A Wilkinson*
3A Winston
3A Yalobusha
3A Yazoo
MISSOURI
5A Adair
5A Andrew
5A Atchison
4A Audrain
4A Barry
4A Barton
4A Bates
4A Benton
4A Bollinger
4A Boone
5A Buchanan
4A Butler

U.S. STATE
5A Caldwell
4A Callaway
4A Camden
4A Cape Girardeau
4A Carroll
4A Carter
4A Cass
4A Cedar
5A Chariton
4A Christian
5A Clark
4A Clay
5A Clinton
4A Cole
4A Cooper
4A Crawford
4A Dade
4A Dallas
5A Daviess
5A DeKalb
4A Dent
4A Douglas
4A Dunklin
4A Franklin
4A Gasconade
5A Gentry
4A Greene
5A Grundy
5A Harrison
4A Henry
4A Hickory
5A Holt
4A Howard
4A Howell
4A Iron
4A Jackson
4A Jasper
4A Jefferson
4A Johnson
5A Knox
4A Laclede
4A Lafayette
4A Lawrence

U.S. STATE
5A Lewis
4A Lincoln
5A Linn
5A Livingston
5A Macon
4A Madison
4A Maries
5A Marion
4A McDonald
5A Mercer
4A Miller
4A Mississippi
4A Moniteau
4A Monroe
4A Montgomery
4A Morgan
4A New Madrid
4A Newton
5A Nodaway
4A Oregon
4A Osage
4A Ozark
4A Pemiscot
4A Perry
4A Pettis
4A Phelps
5A Pike
4A Platte
4A Polk
4A Pulaski
5A Putnam
5A Ralls
4A Randolph
4A Ray
4A Reynolds
4A Ripley
4A Saline
5A Schuyler
5A Scotland
4A Scott
4A Shannon
5A Shelby
4A St. Charles

U.S. STATE
4A St. Clair
4A Ste. Genevieve
4A St. Francois
4A St. Louis
4A St. Louis (city)
4A Stoddard
4A Stone
5A Sullivan
4A Taney
4A Texas
4A Vernon
4A Warren
4A Washington
4A Wayne
4A Webster
5A Worth
4A Wright
MONTANA
6B (all)
NEBRASKA
5A (all)
NEVADA
5B Carson City (city)
5B Churchill
3B Clark
5B Douglas
5B Elko
5B Esmeralda
5B Eureka
5B Humboldt
5B Lander
5B Lincoln
5B Lyon
5B Mineral
5B Nye
5B Pershing
5B Storey
5B Washoe
5B White Pine
NEW HAMPSHIRE
6A Belknap
6A Carroll
5A Cheshire

U.S. STATE
6A Coos
6A Grafton
5A Hillsborough
6A Merrimack
5A Rockingham
5A Strafford
6A Sullivan
NEW JERSEY
4A Atlantic
5A Bergen
4A Burlington
4A Camden
4A Cape May
4A Cumberland
4A Essex
4A Gloucester
4A Hudson
5A Hunterdon
5A Mercer
4A Middlesex
4A Monmouth
5A Morris
4A Ocean
5A Passaic
4A Salem
5A Somerset
5A Sussex
4A Union
5A Warren
NEW MEXICO
4B Bernalillo
5B Catron
3B Chaves
4B Cibola
5B Colfax
4B Curry
4B DeBaca
3B Dona Ana
3B Eddy
4B Grant
4B Guadalupe
5B Harding
3B Hidalgo

U.S. STATE
3B Lea
4B Lincoln
5B Los Alamos
3B Luna
5B McKinley
5B Mora
3B Otero
4B Quay
5B Rio Arriba
4B Roosevelt
5B Sandoval
5B San Juan
5B San Miguel
5B Santa Fe
4B Sierra
4B Socorro
5B Taos
5B Torrance
4B Union
4B Valencia
NEW YORK
5A Albany
6A Allegany
4A Bronx
6A Broome
6A Cattaraugus
5A Cayuga
5A Chautauqua
5A Chemung
6A Chenango
6A Clinton
5A Columbia
5A Cortland
6A Delaware
5A Dutchess
5A Erie
6A Essex
6A Franklin
6A Fulton
5A Genesee
5A Greene
6A Hamilton
6A Herkimer

U.S. STATE
6A Jefferson
4A Kings
6A Lewis
5A Livingston
6A Madison
5A Monroe
6A Montgomery
4A Nassau
4A New York
5A Niagara
6A Oneida
5A Onondaga
5A Ontario
5A Orange
5A Orleans
5A Oswego
6A Otsego
5A Putnam
4A Queens
5A Rensselaer
4A Richmond
5A Rockland
5A Saratoga
5A Schenectady
6A Schoharie
6A Schuyler
5A Seneca
6A Steuben
6A St. Lawrence
4A Suffolk
6A Sullivan
5A Tioga
6A Tompkins
6A Ulster
6A Warren
5A Washington
5A Wayne
4A Westchester
6A Wyoming
5A Yates
NORTH CAROLINA
4A Alamance

U.S. STATE
4A Alexander
5A Alleghany
3A Anson
5A Ashe
5A Avery
3A Beaufort
4A Bertie
3A Bladen
3A Brunswick*
4A Buncombe
4A Burke
3A Cabarrus
4A Caldwell
3A Camden
3A Carteret*
4A Caswell
4A Catawba
4A Chatham
4A Cherokee
3A Chowan
4A Clay
4A Cleveland
3A Columbus*
3A Craven
3A Cumberland
3A Currituck
3A Dare
3A Davidson
4A Davie
3A Duplin
4A Durham
3A Edgecombe
4A Forsyth
4A Franklin
3A Gaston
4A Gates
4A Graham
4A Granville
3A Greene
4A Guilford
4A Halifax
4A Harnett
4A Haywood

U.S. STATE
4A Henderson
4A Hertford
3A Hoke
3A Hyde
4A Iredell
4A Jackson
3A Johnston
3A Jones
4A Lee
3A Lenoir
4A Lincoln
4A Macon
4A Madison
3A Martin
4A McDowell
3A Mecklenburg
5A Mitchell
3A Montgomery
3A Moore
4A Nash
3A New Hanover*
4A Northampton
3A Onslow*
4A Orange
3A Pamlico
3A Pasquotank
3A Pender*
3A Perquimans
4A Person
3A Pitt
4A Polk
3A Randolph
3A Richmond
3A Robeson
4A Rockingham
3A Rowan
4A Rutherford
3A Sampson
3A Scotland
3A Stanly
4A Stokes
4A Surry
4A Swain

U.S. STATE
4A Transylvania
3A Tyrrell
3A Union
4A Vance
4A Wake
4A Warren
3A Washington
5A Watauga
3A Wayne
4A Wilkes
3A Wilson
4A Yadkin
5A Yancey
NORTH DAKOTA
6A Adams
7 Barnes
7 Benson
6A Billings
7 Bottineau
6A Bowman
7 Burke
6A Burleigh
7 Cass
7 Cavalier
6A Dickey
7 Divide
6A Dunn
7 Eddy
6A Emmons
7 Foster
6A Golden Valley
7 Grand Forks
6A Grant
7 Griggs
6A Hettinger
7 Kidder
6A LaMoure
6A Logan
7 McHenry
6A McIntosh
6A McKenzie
7 McLean
6A Mercer

U.S. STATE
6A Morton
7 Mountrail
7 Nelson
6A Oliver
7 Pembina
7 Pierce
7 Ramsey
6A Ransom
7 Renville
6A Richland
7 Rolette
6A Sargent
7 Sheridan
6A Sioux
6A Slope
6A Stark
7 Steele
7 Stutsman
7 Towner
7 Traill
7 Walsh
7 Ward
7 Wells
7 Williams
OHIO
4A Adams
5A Allen
5A Ashland
5A Ashtabula
5A Athens
5A Auglaize
5A Belmont
4A Brown
5A Butler
5A Carroll
5A Champaign
5A Clark
4A Clermont
5A Clinton
5A Columbiana
5A Coshocton
5A Crawford
5A Cuyahoga

U.S. STATE
5A Darke
5A Defiance
5A Delaware
5A Erie
5A Fairfield
5A Fayette
5A Franklin
5A Fulton
4A Gallia
5A Geauga
5A Greene
5A Guernsey
4A Hamilton
5A Hancock
5A Hardin
5A Harrison
5A Henry
5A Highland
5A Hocking
5A Holmes
5A Huron
5A Jackson
5A Jefferson
5A Knox
5A Lake
4A Lawrence
5A Licking
5A Logan
5A Lorain
5A Lucas
5A Madison
5A Mahoning
5A Marion
5A Medina
5A Meigs
5A Mercer
5A Miami
5A Monroe
5A Montgomery
5A Morgan
5A Morrow
5A Muskingum
5A Noble

U.S. STATE
5A Ottawa
5A Paulding
5A Perry
5A Pickaway
4A Pike
5A Portage
5A Preble
5A Putnam
5A Richland
5A Ross
5A Sandusky
4A Scioto
5A Seneca
5A Shelby
5A Stark
5A Summit
5A Trumbull
5A Tuscarawas
5A Union
5A Van Wert
5A Vinton
5A Warren
4A Washington
5A Wayne
5A Williams
5A Wood
5A Wyandot
OKLAHOMA
3A Adair
3A Alfalfa
3A Atoka
4B Beaver
3A Beckham
3A Blaine
3A Bryan
3A Caddo
3A Canadian
3A Carter
3A Cherokee
3A Choctaw
4B Cimarron
3A Cleveland
3A Coal

U.S. STATE
3A Comanche
3A Cotton
3A Craig
3A Creek
3A Custer
3A Delaware
3A Dewey
3A Ellis
3A Garfield
3A Garvin
3A Grady
3A Grant
3A Greer
3A Harmon
3A Harper
3A Haskell
3A Hughes
3A Jackson
3A Jefferson
3A Johnston
3A Kay
3A Kingfisher
3A Kiowa
3A Latimer
3A Le Flore
3A Lincoln
3A Logan
3A Love
3A Major
3A Marshall
3A Mayes
3A McClain
3A McCurtain
3A McIntosh
3A Murray
3A Muskogee
3A Noble
3A Nowata
3A Okfuskee
3A Oklahoma
3A Okmulgee
3A Osage
3A Ottawa

U.S. STATE
3A Pawnee
3A Payne
3A Pittsburg
3A Pontotoc
3A Pottawatomie
3A Pushmataha
3A Roger Mills
3A Rogers
3A Seminole
3A Sequoyah
3A Stephens
4B Texas
3A Tillman
3A Tulsa
3A Wagoner
3A Washington
3A Washita
3A Woods
3A Woodward
OREGON
5B Baker
4C Benton
4C Clackamas
4C Clatsop
4C Columbia
4C Coos
5B Crook
4C Curry
5B Deschutes
4C Douglas
5B Gilliam
5B Grant
5B Harney
5B Hood River
4C Jackson
5B Jefferson
4C Josephine
5B Klamath
5B Lake
4C Lane
4C Lincoln
4C Linn
5B Malheur

U.S. STATE
4C Marion
5B Morrow
4C Multnomah
4C Polk
5B Sherman
4C Tillamook
5B Umatilla
5B Union
5B Wallowa
5B Wasco
4C Washington
5B Wheeler
4C Yamhill
PENNSYLVANIA
5A Adams
5A Allegheny
5A Armstrong
5A Beaver
5A Bedford
5A Berks
5A Blair
5A Bradford
4A Bucks
5A Butler
5A Cambria
6A Cameron
5A Carbon
5A Centre
4A Chester
5A Clarion
6A Clearfield
5A Clinton
5A Columbia
5A Crawford
5A Cumberland
5A Dauphin
4A Delaware
6A Elk
5A Erie
5A Fayette
5A Forest
5A Franklin
5A Fulton

U.S. STATE
5A Greene
5A Huntingdon
5A Indiana
5A Jefferson
5A Juniata
5A Lackawanna
5A Lancaster
5A Lawrence
5A Lebanon
5A Lehigh
5A Luzerne
5A Lycoming
6A McKean
5A Mercer
5A Mifflin
5A Monroe
4A Montgomery
5A Montour
5A Northampton
5A Northumberland
5A Perry
4A Philadelphia
5A Pike
6A Potter
5A Schuylkill
5A Snyder
5A Somerset
5A Sullivan
6A Susquehanna
6A Tioga
5A Union
5A Venango
5A Warren
5A Washington
6A Wayne
5A Westmoreland
5A Wyoming
4A York
RHODE ISLAND
5A (all)
SOUTH CAROLINA
3A Abbeville
3A Aiken

U.S. STATE
3A Allendale*
3A Anderson
3A Bamberg*
3A Barnwell*
3A Beaufort*
3A Berkeley*
3A Calhoun
3A Charleston*
3A Cherokee
3A Chester
3A Chesterfield
3A Clarendon
3A Colleton*
3A Darlington
3A Dillon
3A Dorchester*
3A Edgefield
3A Fairfield
3A Florence
3A Georgetown*
3A Greenville
3A Greenwood
3A Hampton*
3A Horry*
3A Jasper*
3A Kershaw
3A Lancaster
3A Laurens
3A Lee
3A Lexington
3A Marion
3A Marlboro
3A McCormick
3A Newberry
3A Oconee
3A Orangeburg
3A Pickens
3A Richland
3A Saluda
3A Spartanburg
3A Sumter
3A Union
3A Williamsburg

U.S. STATE
3A York
SOUTH DAKOTA
6A Aurora
6A Beadle
5A Bennett
5A Bon Homme
6A Brookings
6A Brown
6A Brule
6A Buffalo
6A Butte
6A Campbell
5A Charles Mix
6A Clark
5A Clay
6A Codington
6A Corson
6A Custer
6A Davison
6A Day
6A Deuel
6A Dewey
5A Douglas
6A Edmunds
6A Fall River
6A Faulk
6A Grant
5A Gregory
6A Haakon
6A Hamlin
6A Hand
6A Hanson
6A Harding
6A Hughes
5A Hutchinson
6A Hyde
5A Jackson
6A Jerauld
6A Jones
6A Kingsbury
6A Lake
6A Lawrence
6A Lincoln

U.S. STATE
6A Lyman
6A Marshall
6A McCook
6A McPherson
6A Meade
5A Mellette
6A Miner
6A Minnehaha
6A Moody
6A Pennington
6A Perkins
6A Potter
6A Roberts
6A Sanborn
6A Shannon
6A Spink
6A Stanley
6A Sully
5A Todd
5A Tripp
6A Turner
5A Union
6A Walworth
5A Yankton
6A Ziebach
TENNESSEE
4A Anderson
4A Bedford
4A Benton
4A Bledsoe
4A Blount
4A Bradley
4A Campbell
4A Cannon
4A Carroll
4A Carter
4A Cheatham
3A Chester
4A Claiborne
4A Clay
4A Cocke
4A Coffee
3A Crockett

U.S. STATE
4A Cumberland
4A Davidson
4A Decatur
4A DeKalb
4A Dickson
3A Dyer
3A Fayette
4A Fentress
4A Franklin
4A Gibson
4A Giles
4A Grainger
4A Greene
4A Grundy
4A Hamblen
4A Hamilton
4A Hancock
3A Hardeman
3A Hardin
4A Hawkins
3A Haywood
3A Henderson
4A Henry
4A Hickman
4A Houston
4A Humphreys
4A Jackson
4A Jefferson
4A Johnson
4A Knox
3A Lake
3A Lauderdale
4A Lawrence
4A Lewis
4A Lincoln
4A Loudon
4A Macon
3A Madison
4A Marion
4A Marshall
4A Maury
4A McMinn
3A McNairy

U.S. STATE
4A Meigs
4A Monroe
4A Montgomery
4A Moore
4A Morgan
4A Obion
4A Overton
4A Perry
4A Pickett
4A Polk
4A Putnam
4A Rhea
4A Roane
4A Robertson
4A Rutherford
4A Scott
4A Sequatchie
4A Sevier
3A Shelby
4A Smith
4A Stewart
4A Sullivan
4A Sumner
3A Tipton
4A Trousdale
4A Unicoi
4A Union
4A Van Buren
4A Warren
4A Washington
4A Wayne
4A Weakley
4A White
4A Williamson
4A Wilson
TEXAS
2A Anderson*
3B Andrews
2A Angelina*
2A Aransas*
3A Archer
4B Armstrong
2A Atascosa*

U.S. STATE
2A Austin*
4B Bailey
2B Bandera*
2A Bastrop*
3B Baylor
2A Bee*
2A Bell*
2A Bexar*
3A Blanco*
3B Borden
2A Bosque*
3A Bowie*
2A Brazoria*
2A Brazos*
3B Brewster
4B Briscoe
2A Brooks*
3A Brown*
2A Burleson*
3A Burnet*
2A Caldwell*
2A Calhoun*
3B Callahan
2A Cameron*
3A Camp*
4B Carson
3A Cass*
4B Castro
2A Chambers*
2A Cherokee*
3B Childress
3A Clay
4B Cochran
3B Coke
3B Coleman
3A Collin*
3B Collingsworth
2A Colorado*
2A Comal*
3A Comanche*
3B Concho
3A Cooke
2A Coryell*

U.S. STATE
3B Cottle
3B Crane
3B Crockett
3B Crosby
3B Culberson
4B Dallam
3A Dallas*
3B Dawson
4B Deaf Smith
3A Delta
3A Denton*
2A DeWitt*
3B Dickens
2B Dimmit*
4B Donley
2A Duval*
3A Eastland
3B Ector
2B Edwards*
3A Ellis*
3B El Paso
3A Erath*
2A Falls*
3A Fannin
2A Fayette*
3B Fisher
4B Floyd
3B Foard
2A Fort Bend*
3A Franklin*
2A Freestone*
2B Frio*
3B Gaines
2A Galveston*
3B Garza
3A Gillespie*
3B Glasscock
2A Goliad*
2A Gonzales*
4B Gray
3A Grayson
3A Gregg*
2A Grimes*

U.S. STATE
2A Guadalupe*
4B Hale
3B Hall
3A Hamilton*
4B Hansford
3B Hardeman
2A Hardin*
2A Harris*
3A Harrison*
4B Hartley
3B Haskell
2A Hays*
3B Hemphill
3A Henderson*
2A Hidalgo*
2A Hill*
4B Hockley
3A Hood*
3A Hopkins*
2A Houston*
3B Howard
3B Hudspeth
3A Hunt*
4B Hutchinson
3B Irion
3A Jack
2A Jackson*
2A Jasper*
3B Jeff Davis
2A Jefferson*
2A Jim Hogg*
2A Jim Wells*
3A Johnson*
3B Jones
2A Karnes*
3A Kaufman*
3A Kendall*
2A Kenedy*
3B Kent
3B Kerr
3B Kimble
3B King
2B Kinney*

U.S. STATE
2A Kleberg*
3B Knox
3A Lamar*
4B Lamb
3A Lampasas*
2B La Salle*
2A Lavaca*
2A Lee*
2A Leon*
2A Liberty*
2A Limestone*
4B Lipscomb
2A Live Oak*
3A Llano*
3B Loving
3B Lubbock
3B Lynn
2A Madison*
3A Marion*
3B Martin
3B Mason
2A Matagorda*
2B Maverick*
3B McCulloch
2A McLennan*
2A McMullen*
2B Medina*
3B Menard
3B Midland
2A Milam*
3A Mills*
3B Mitchell
3A Montague
2A Montgomery*
4B Moore
3A Morris*
3B Motley
3A Nacogdoches*
3A Navarro*
2A Newton*
3B Nolan
2A Nueces*
4B Ochiltree

U.S. STATE
4B Oldham
2A Orange*
3A Palo Pinto*
3A Panola*
3A Parker*
4B Parmer
3B Pecos
2A Polk*
4B Potter
3B Presidio
3A Rains*
4B Randall
3B Reagan
2B Real*
3A Red River*
3B Reeves
2A Refugio*
4B Roberts
2A Robertson*
3A Rockwall*
3B Runnels
3A Rusk*
3A Sabine*
3A San Augustine*
2A San Jacinto*
2A San Patricio*
3A San Saba*
3B Schleicher
3B Scurry
3B Shackelford
3A Shelby*
4B Sherman
3A Smith*
3A Somervell*
2A Starr*
3A Stephens
3B Sterling
3B Stonewall
3B Sutton
4B Swisher
3A Tarrant*
3B Taylor
3B Terrell

U.S. STATE
3B Terry
3B Throckmorton
3A Titus*
3B Tom Green
2A Travis*
2A Trinity*
2A Tyler*
3A Upshur*
3B Upton
2B Uvalde*
2B Val Verde*
3A Van Zandt*
2A Victoria*
2A Walker*
2A Waller*
3B Ward
2A Washington*
2B Webb*
2A Wharton*
3B Wheeler
3A Wichita
3B Wilbarger
2A Willacy*
2A Williamson*
2A Wilson*
3B Winkler
3A Wise
3A Wood*
4B Yoakum
3A Young
2B Zapata*
2B Zavala*
UTAH
5B Beaver
6B Box Elder
6B Cache
6B Carbon
6B Daggett
5B Davis
6B Duchesne
5B Emery
5B Garfield
5B Grand

U.S. STATE
5B Iron
5B Juab
5B Kane
5B Millard
6B Morgan
5B Piute
6B Rich
5B Salt Lake
5B San Juan
5B Sanpete
5B Sevier
6B Summit
5B Tooele
6B Uintah
5B Utah
6B Wasatch
3B Washington
5B Wayne
5B Weber
VERMONT
6A (all)
VIRGINIA
4A (all)
WASHINGTON
5B Adams
5B Asotin
5B Benton
5B Chelan
4C Clallam
4C Clark
5B Columbia
4C Cowlitz
5B Douglas
6B Ferry
5B Franklin
5B Garfield
5B Grant
4C Grays Harbor
4C Island
4C Jefferson
4C King
4C Kitsap
5B Kittitas

U.S. STATE
5B Klickitat
4C Lewis
5B Lincoln
4C Mason
6B Okanogan
4C Pacific
6B Pend Oreille
4C Pierce
4C San Juan
4C Skagit
5B Skamania
4C Snohomish
5B Spokane
6B Stevens
4C Thurston
4C Wahkiakum
5B Walla Walla
4C Whatcom
5B Whitman
5B Yakima
WEST VIRGINIA
5A Barbour
4A Berkeley
4A Boone
4A Braxton
5A Brooke
4A Cabell
4A Calhoun
4A Clay
5A Doddridge
5A Fayette
4A Gilmer
5A Grant
5A Greenbrier
5A Hampshire
5A Hancock
5A Hardy
5A Harrison
4A Jackson
4A Jefferson
4A Kanawha
5A Lewis
4A Lincoln

U.S. STATE
4A Logan
5A Marion
5A Marshall
4A Mason
4A McDowell
4A Mercer
5A Mineral
4A Mingo
5A Monongalia
4A Monroe

U.S. STATE
4A Morgan
5A Nicholas
5A Ohio
5A Pendleton
4A Pleasants
5A Pocahontas
5A Preston
4A Putnam
5A Raleigh
5A Randolph

U.S. STATE
4A Ritchie
4A Roane
5A Summers
5A Taylor
5A Tucker
4A Tyler
5A Upshur
4A Wayne
5A Webster
5A Wetzel

U.S. STATE
4A Wirt
4A Wood
4A Wyoming
WISCONSIN
6A Adams
7 Ashland
6A Barron
7 Bayfield
6A Brown
6A Buffalo

U.S. STATE
7 Burnett
6A Calumet
6A Chippewa
6A Clark
6A Columbia
6A Crawford
6A Dane
6A Dodge
6A Door
7 Douglas
6A Dunn
6A Eau Claire
7 Florence
6A Fond du Lac
7 Forest
6A Grant
6A Green
6A Green Lake
6A Iowa
7 Iron
6A Jackson
6A Jefferson
6A Juneau
6A Kenosha
6A Kewaunee

U.S. STATE
6A La Crosse
6A Lafayette
7 Langlade
7 Lincoln
6A Manitowoc
6A Marathon
6A Marinette
6A Marquette
6A Menominee
6A Milwaukee
6A Monroe
6A Oconto
7 Oneida
6A Outagamie
6A Ozaukee
6A Pepin
6A Pierce
6A Polk
6A Portage
7 Price
6A Racine
6A Richland
6A Rock
6A Rusk
6A Sauk

U.S. STATE
7 Sawyer
6A Shawano
6A Sheboygan
6A St. Croix
7 Taylor
6A Trempealeau
6A Vernon
7 Vilas
6A Walworth
7 Washburn
6A Washington
6A Waukesha
6A Waupaca
6A Waushara
6A Winnebago
6A Wood
WYOMING
6B Albany
6B Big Horn
6B Campbell
6B Carbon
6B Converse
6B Crook
6B Fremont
5B Goshen
6B Hot Springs
6B Johnson
6B Laramie
7 Lincoln
6B Natrona
6B Niobrara
6B Park
5B Platte
6B Sheridan
7 Sublette
6B Sweetwater
7 Teton
6B Uinta
6B Washakie
6B Weston
U.S. TERRITORIES
AMERICAN SAMOA

U.S. STATE
1A (all)*
GUAM
1A (all)*
NORTHERN MARIANA ISLANDS
1A (all)*
PUERTO RICO
1A (all)*
VIRGIN ISLANDS
1A (all)*

Modify Appendix C, Sections C3.3 through C3.5, as follows (I-P and SI units).

C3.3 The *vertical fenestration area* of each *space-conditioning category* in the base envelope design shall be the same as the proposed building or ~~40% of the *gross wall area*~~ the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is less. The distribution of *vertical fenestration* among *space-conditioning categories* and surface orientations shall be the same as the proposed design. If the *vertical fenestration area* of any *space-conditioning category* is greater than ~~40% of the *gross wall area* of~~ the maximum allowed in Tables 5.5-1 through 5.5-8 for that *space-conditioning category*, then the area of each *fenestration* element shall be reduced in the base envelope design by the same percentage so that the total *vertical fenestration area* is exactly equal to ~~40% of the *gross wall area*~~ the maximum allowed in Tables 5.5-1 through 5.5-8.

C3.4 The *skylight area* of each space category in the base envelope design shall be the same as the proposed building or ~~5% of the *gross roof area*~~ the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is less. This distribution of *skylights* among *space-conditioning categories* shall be the same as the proposed design. If the *skylight area* of any space category is greater than ~~5% of the *gross roof area* of~~ the maximum allowed in Tables 5.5-1 through 5.5-8 for that *space-conditioning category*, then the area of each *skylight* shall be reduced in the base envelope design by the same percentage so that the total *skylight area* is exactly equal ~~to 5% of the *gross roof area*~~ the maximum allowed in Tables 5.5-1 through 5.5-8.

C3.5 The *U-factor* for *fenestration* in the base envelope design shall be equal to the criteria from Tables 5.5-1 through 5.5-8 for the appropriate climate. The *SHGC* for *fenestration* in the base envelope design shall be equal to the criteria from Tables 5.5-1 through 5.5-8. For portions of those tables where there are no SHGC requirements, the *SHGC* shall be equal to ~~0.46~~ 0.40 for all *vertical fenestration*~~,~~ and 0.55 for *skylights* ~~0.77 for plastic *skylights* on a curb, and 0.72 for all other *skylights* with a curb and without~~. The ~~VLT~~ VT for *fenestration* in the base envelope design shall be ~~the VLT factor from Table C3.5 for the appropriate climate~~ equal to 1.10 times the *SHGC* criteria as determined in this subsection.

~~TABLE C3.5 VLT Factor for the Base Envelope Design~~

~~Climate Bin~~	~~Vertical Fenestration~~	~~Glass Skylights~~	~~Plastic Skylights~~
~~1(A, B)~~	~~1.00~~	~~1.27~~	~~1.20~~
~~2(A, B)~~	~~1.00~~	~~1.27~~	~~1.20~~
~~3(C)~~	~~1.00~~	~~1.27~~	~~1.20~~
~~3(A, B)~~	~~1.27~~	~~1.27~~	~~1.20~~
~~4(A, B, C)~~	~~1.27~~	~~1.27~~	~~1.20~~
~~5(A, B, C)~~	~~1.27~~	~~1.27~~	~~1.20~~
~~6(A, B)~~	~~1.27~~	~~1.27~~	~~1.20~~
~~7~~	~~1.00~~	~~1.00~~	~~1.20~~
~~8~~	~~1.00~~	~~1.00~~	~~1.20~~

Modify Appendix G, Table G3.1, #5, as follows (I-P and SI units).

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

Proposed Building Performance	Baseline Building Performance
5. Building Envelope	

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

All components of the building envelope in the proposed design shall be modeled as shown on architectural drawings or as built for existing building envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. a. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages, roof parapet) shall be separately modeled using either of the following techniques: 1. Separate model of each of these assemblies within the energy simulation model. 2. Separate calculation of the U-factor for each of these assemblies. The U-factors of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average U-factor is modeled within the energy simulation model. Any other envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described provided that it is similar to an assembly being modeled. If not separately described, the area of an envelope assembly shall be added to the area of an assembly of that same type with the same orientation and thermal properties. b. Exterior surfaces whose azimuth orientation and tilt differ by less than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. c. For exterior roofs, the roof surface may be modeled with a reflectance of 0.45 if the reflectance of the proposed design roof is greater than 0.70 and its emittance is greater than 0.75 or has a minimum SRI of 82. Reflectance values shall be based on testing in accordance with ASTM C1549, ASTM E903, or ASTM E1918, and emittance values shall be based on testing in accordance with ASTM C1371 or ASTM E408, and SRI shall be based on ASTM E1980 calculated at medium wind speed. All other roof surfaces shall be modeled with a reflectance of 0.30. d. Manual fenestration shading devices such as blinds or shades shall not be modeled. Automatically controlled fenestration shades or blinds may be modeled. Permanent shading devices such as fins, overhangs, and light shelves may be modeled.	Equivalent dimensions shall be assumed for each exterior envelope component type as in the proposed design; i.e., the total gross area of exterior walls shall be the same in the proposed and baseline building designs. The same shall be true for the areas of roofs, floors, and doors, and the exposed perimeters of concrete slabs on grade shall also be the same in the proposed and baseline building designs. The following additional requirements shall apply to the modeling of the baseline building design: a. Orientation. The baseline building performance shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. b. Opaque Assemblies. Opaque assemblies used for new buildings or additions shall conform with the following common, lightweight assembly types and shall match the appropriate assembly maximum U-factors in Tables 5.5-1 through 5.5-8: • Roofs—Insulation entirely above deck • Above-grade walls—Steel-framed • Floors—Steel-joist • Opaque door types shall match the proposed design and conform to the U-factor requirements from the same tables. • Slab-on-grade floors shall match the F-factor for unheated slabs from the same tables. Opaque assemblies used for alterations shall conform with Section 5.1.3. c. Vertical Fenestration. Vertical fenestration areas for new buildings and additions shall equal that in the proposed design or ~~40% of gross above-grade wall area~~ the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is smaller, and shall be distributed on each face of the building in the same proportions in the proposed design. Fenestration U-factors shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. Fenestration SHGC shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. For portions of those tables where there are no SHGC requirements, the SHGC shall be equal to that determined in accordance with Section C3.5. The VT shall be equal to that determined in accordance with Section C3.5. All vertical ~~glazing~~fenestration shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled. Manual window shading devices such as blinds or shades shall not be modeled. The fenestration areas for envelope alterations shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3. d. Skylights and Glazed Smoke Vents. Skylight area shall be equal to that in the proposed building design or ~~5% of the gross roof area that is part of the building envelope~~ the maximum allowed in Tables 5.5-1 through 5.5-8, whichever is smaller. If the skylight area of the proposed building design is greater than ~~5% of the gross roof area~~ the maximum allowed in Tables 5.5-1 through 5.5-8, baseline skylight area shall be decreased by an identical percentage in all roof components in which skylights are located to reach ~~the 5% skylight-to-roof ratio~~ the maximum allowed in Tables 5.5-1 through 5.5-8. Skylight orientation and tilt shall be the same as in the proposed building design. Skylight U-factor and SHGC properties shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. e. Roof albedo. All roof surfaces shall be modeled with a reflectivity of 0.30. f. Existing Buildings. For existing building envelopes, the baseline building design shall reflect existing conditions prior to any revisions that are part of the scope of work being evaluated.

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

FOREWORD

These revisions introduce automatic lighting control to guestroom-type spaces for additional energy savings and also allow captive key systems that provide similar savings control to comply.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bc to Standard 90.1-2010

Revise the standard as follows (I-P and SI).

9.4.1.6 Additional Control. Additional controls shall meet the following requirements:

[. . .]

c. **Guest Room Lighting.** Lighting and switched receptacles in guestrooms and suites ~~Guestrooms~~ in hotels, motels, boarding houses, or similar buildings shall be automatically controlled such that the power to the lighting and switched receptacles will be turned off within 20 minutes after all occupants leave the room ~~have one or more control device(s) at the entry door that collectively control all permanently installed luminaires and switched receptacles, except those the lighting in the bathroom(s). at the entry to each room or at the primary entry to the suite~~. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting, except for night lighting not exceeding 5 W, within 60 minutes of the occupant leaving the space.~~"~~

Exception: Lighting and switched receptacles controlled by captive key systems.

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FOREWORD

These revisions add more specific requirements to the functional testing of lighting controls for the common controls required by the standard and adds some clarification to the description of entities allowed to perform the testing and verification.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bd to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

9.4.4 Functional Testing. Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. The requirement for functional testing shall be stated in construction documents. When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

~~a. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.~~

~~b. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.~~

~~c. Confirm that photosensor controls reduce electric light levels based on the amount of usable daylight in the space as specified.~~

a. Occupant Sensors

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

b. Automatic Time Switches

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

c. Daylight Controls

1. All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate setpoints and threshold light levels.
2. Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
3. The location where calibration adjustments are made is readily accessible only to authorized personnel.

~~The construction documents shall state the party who will conduct and certify the functional testing.~~ The ~~party~~ individual(s) responsible for the functional testing, shall not be directly involved in either the design or construction of the project and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria. ~~Certification shall be specific enough to verify conformance.~~

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FOREWORD

This addendum makes minor changes to ensure the intended scope of the lighting section.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum be to Standard 90.1-2010

Revise the Standard as follows for I-P and SI units.

9.7 Submittals

...

9.7.2.2 Manuals. Construction documents shall require for all lighting *equipment* and lighting controls, an operating and maintenance manual be provided to the building owner or the designated representative of the building owner within 90 days after the date of *system* acceptance. These manuals shall include, at a minimum, the following:

a. Submittal data indicating all selected options for each piece of lighting *equipment*<u>, including but not limited to lamps, ballasts, drivers,</u> and lighting controls.
b. Operation and maintenance manuals for each piece of lighting *equipment* and lighting controls with routine maintenance clearly identified including, as a minimum, a recommended relamping<u>/cleaning</u> program and a schedule for inspecting and recalibrating all lighting controls.
c. A complete narrative of how each lighting control *system* is intended to operate including recommended settings.

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FOREWORD

These revisions

- *increase the spaces where plug shut-off control is required,*
- *clarify the application of the requirement to furniture systems,*
- *state a labeling requirement, and*
- *restrict the use of nonpermanent equipment.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bf to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

8.4.2 Automatic Receptacle Control. The following shall be automatically controlled:

a. At least 50% of all 125 V 15- and 20-amp receptacles in all private offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, classrooms, and individual workstations

b. At least 25% of branch circuit feeders installed for modular furniture not shown on the construction documents.~~,~~ ~~including those installed in modular partitions, installed in the following space types:~~

~~a. Private offices~~
~~b. Open offices~~
~~c. Computer Classrooms~~

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

This control shall function on

a. a scheduled basis using a time-of-day operated control device that turns receptacles off at specific programmed times—an independent program schedule shall be provided for controlled areas of no more than ~~2~~5000 ft^2 (~~9620~~464.5 m^2) ~~but~~ and not more than one floor (the occupant shall be able to manually override the control device for up to two hours),

b. an occupant sensor that shall turn receptacles off within ~~30~~ 20 minutes of all occupants leaving a space, or

c. ~~a~~ an automated signal from another control or alarm system that shall turn receptacles off within 20 minutes after determining that the area is unoccupied~~indicates the area is unoccupied~~.

All controlled receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles and are to be uniformly distributed throughout the space.

Plug-in devices shall not be used to comply with Section 8.4.2.

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

a. Receptacles specifically designated for equipment requiring continuous operation (24 hours/day, 365 days/year) ~~24 hour operation~~.

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

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FOREWORD

The purpose of this addendum is to update the exception related to storm windows under envelope alterations. Storm windows/glazing panels added over existing windows can be either inside or outside, but this is not clear in the current language. Additionally, these products are often referred to by names other than storm windows, and the term "panel" is more accurate, particularly for products added to the interior of the window.

Additionally, technology has advanced where these glazing panels can include a low-e coating rather than just clear uncoated glass, providing additional energy savings. An analysis showed that the additional cost for the low-e coating was justified. Therefore, the exception was updated to require a low-emissivity coating.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bg to Standard 90.1-2010

Revise the standard as follows (I-P and SI Units)

5.1.3 Envelope Alterations. Alterations to the building envelope shall comply with the requirements of Section 5 for insulation, air leakage, and fenestration applicable to those specific portions of the building that are being altered.

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

a. Installation of storm windows or glazing panels over existing glazing, provided the storm window or glazing panel contains a low-emissivity coating. However, a low-emissivity coating is not required where the existing glazing already has a low-emissivity coating. Installation is permitted to be either on the inside or outside of the existing glazing.

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

FOREWORD

Table 9.6.1 has been modified for the following purposes:

- *Lighting Power Densities (LPDs) have been adjusted to account for changes to recommended light levels as published in the new, of IES’* The Lighting Handbook, 10th Edition. *Some values have increased while others have gone decreased.*
- *Three new space types have been added in response to user requests: (a) Copy/Print Rooms; (b) Loading Docks, Interior; and (c) Computer Rooms.*
- *Also in response to user requests, new space types for Assisted Living Facilities were added, including corridor, dining area, lobby, restroom, chapel, and recreation room. In all cases, these modified LPDs are restricted to those spaces that are used primarily by the residents.*
- *Some space types were renamed for consistency.*
- *Some table footnotes were added to provide more specific direction.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bh to Standard 90.1-2010

Replace current Table 9.6.1 with the following tables (I-P and SI units, respectively).

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method (I-P)

Common Space Types[1]	LPD, W/ft²	RCR Threshold
Audience Seating Area		
... in an auditorium	0.63	6
... in a convention center	0.82	4
… in a gymnasium	0.65	6
... in a motion picture theater	1.14	4
... in a penitentiary	0.28	4
... in a performing arts theater	2.43	8
... in a religious building	1.53	4
... in a sports arena	0.43	4
… otherwise	0.43	4
Atrium		
… that is <=*40 ft in height*	0.03 per foot in total height	NA
… that is >40 ft in height	0.40 + 0.02 per foot in total height	NA
Banking Activity Area	1.01	6
Breakroom (see Lounge/Breakroom)		
Classroom/Lecture Hall/Training Room		
… in a penitentiary	1.34	4
… otherwise	1.24	4
Conference/Meeting/Multipurpose Room	1.23	6
Confinement Cells	0.81	6
Copy/Print Room	0.72	6
Corridor[2]		
… in an assisted living facility (and used primarily by residents)[3]	0.92	width <8 ft
… in a hospital	0.79	width <8 ft
… in a manufacturing facility	0.41	width <8 ft
… otherwise	0.66	width <8 ft
Courtroom	1.72	6
Computer Room	1.71	4
Dining Area		
… in a penitentiary	0.96	6
… in an assisted living facility (and used primarily by residents)[3]	1.90	4
… in bar/lounge or leisure dining	1.07	4

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a “picking area.”

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method (I-P) *(continued)*

Common Space Types[1]	LPD, W/ft[2]	RCR Threshold
… in cafeteria or fast food dining	0.65	4
… in family dining	0.89	4
… otherwise	0.65	4
Electrical/Mechanical Room	0.42	6
Emergency Vehicle Garage	0.56	4
Food Preparation Area	1.21	6
Guest Room	0.47	6
Laboratory		
… in or as a classroom	1.43	6
… otherwise	1.81	6
Laundry/Washing Area	0.60	4
Loading Dock, Interior	0.47	6
Lobby		
… in an assisted living facility (and used primarily by residents)[3]	1.80	4
… for an elevator	0.64	6
… in a hotel	1.06	4
… in a motion picture theater	0.59	4
… in a performing arts theater	2.00	6
… otherwise	0.90	4
Locker Room	0.75	6
Lounge/Breakroom		
… in a healthcare facility	0.92	6
… otherwise	0.73	4
Office		
… enclosed	1.11	8
… open plan	0.98	4
Parking Area, Interior	0.19	4
Pharmacy Area	1.68	6
Restroom		
… in an assisted living facility (and used primarily by residents)[3]	1.21	8
… otherwise	0.98	8
Sales Area[4]	1.59	6
Seating Area, General	0.54	4
Stairwell	0.69	10

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method (I-P) ***(continued)***

Common Space Types[1]	LPD, W/ft[2]	RCR Threshold
Storage Room	0.63	6
Vehicular Maintenance Area	0.67	4
Workshop	1.59	6
Assisted Living Facility[3]		
… in a chapel (used primarily by residents)	2.21	4
… in a recreation room (used primarily by residents)	2.41	6
Automotive (see "Vehicular Maintenance Area")		
Convention Center—Exhibit Space	1.45	4
Dormitory—Living Quarters	0.38	8
Fire Station—Sleeping Quarters	0.22	6
Gymnasium/Fitness Center		
… in an exercise area	0.72	4
… in a playing area	1.20	4
Healthcare Facility		
… in an exam/treatment room	1.66	8
… in an imaging room	1.51	6
… in a medical supply room	0.74	6
… in a nursery	0.88	6
… in a nurse's station	0.71	6
… in an operating room	2.48	6
… in a patient room	0.62	6
… in a physical therapy room	0.91	6
… in a recovery room	1.15	6
Library		
… in a reading area	1.06	4
… in the stacks	1.71	4
Manufacturing Facility		
… in a detailed manufacturing area	1.29	4
… in an equipment room	0.74	6
… in an extra-high bay area (>50 ft floor-to-ceiling height)	1.05	4
… in a high bay area (25–50 ft floor-to-ceiling height)	1.23	4
… in a low bay area (<25 ft floor-to-ceiling height)	1.19	4
Museum		
… in a general exhibition area	1.05	6
… in a restoration room	1.02	6

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method (I-P) *(continued)*

Common Space Types[1]	LPD, W/ft^2	RCR Threshold
Performing Arts Theater—Dressing Room	0.61	6
Post Office—Sorting Area	0.94	4
Religious Buildings		
… in a fellowship hall	0.64	4
… in a worship/pulpit/choir area	1.53	4
Retail Facilities		
… in a dressing/fitting room	0.71	8
… in a mall concourse	1.10	4
Sports Arena—Playing Area		
… for a Class I facility	3.68	4
… for a Class II facility	2.40	4
… for a Class III facility	1.80	4
… for a Class IV facility	1.20	4
Transportation Facility		
… in a baggage/carousel Area	0.53	4
… in an airport concourse	0.36	4
… at a terminal ticket counter	0.80	4
Warehouse—Storage Area		
…for medium to bulky, palletized items	0.58	4
… for smaller, hand-carried items[5]	0.95	6

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method (SI)

Common Space Types[1]	LPD, W/m²	RCR Threshold
Audience Seating Area		
... in an auditorium	6.8	6
... in a convention center	8.9	4
… in a gymnasium	7.1	6
... in a motion picture theater	12.3	4
... in a penitentiary	3.1	4
... in a performing arts theater	26.2	8
... in a religious building	16.5	4
... in a sports arena	4.7	4
… otherwise	4.7	4
Atrium		
… that is <=12.192 m in height	1.059 per meter in total height	NA
… that is >12.192 m in height	4.3 + 0.706 per meter in total height	NA
Banking Activity Area	11.9	6
Breakroom (see Lounge/Breakroom)		
Classroom/Lecture Hall/Training Room		
… in a penitentiary	14.5	4
… otherwise	13.4	4
Conference/Meeting/Multipurpose Room	13.3	6
Confinement Cells	8.8	6
Copy/Print Room	7.8	6
Corridor[2]		
… in an assisted living facility (and used primarily by residents)[3]	9.9	width <2.4 m
… in a hospital	8.5	width <2.4 m
… in a manufacturing facility	4.4	width <2.4 m
… otherwise	7.1	width <2.4 m
Courtroom	18.6	6
Computer Room	18.4	4
Dining Area		
… in a penitentiary	10.4	6
… in an assisted living facility (and used primarily by residents)[3]	20.5	4
… in bar/lounge or leisure dining	11.6	4

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 2.4 m and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method *(continued)* (SI)

Common Space Types[1]	LPD, W/m²	RCR Threshold
… in cafeteria or fast food dining	7.0	4
… in family dining	9.6	4
… otherwise	7.0	4
Electrical/Mechanical Room	4.6	6
Emergency Vehicle Garage	6.1	4
Food Preparation Area	13.1	6
Guest Room	5.1	6
Laboratory		
… in or as a classroom	15.5	6
… otherwise	19.5	6
Laundry/Washing Area	6.5	4
Loading Dock, Interior	5.1	6
Lobby		
… in an assisted living facility (and used primarily by residents)[3]	19.4	4
… for an elevator	7.0	6
… in a hotel	11.5	4
… in a motion picture theater	6.4	4
… in a performing arts theater	21.6	6
… otherwise	9.7	4
Locker Room	8.1	6
Lounge/Breakroom		
… in a healthcare facility	10.0	6
… otherwise	7.9	4
Office		
… enclosed	12.0	8
… open plan	10.6	4
Parking Area, Interior	2.1	4
Pharmacy Area	18.1	6
Restroom		
… in an assisted living facility (and used primarily by residents)[3]	13.1	8
… otherwise	10.6	8
Sales Area[4]	17.2	6
Seating Area, General	5.9	4
Stairwell	7.4	10

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 2.4 m and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method *(continued)* (SI)

Common Space Types[1]	LPD, W/m^2	RCR Threshold
Storage Room	6.8	6
Vehicular Maintenance Area	7.3	4
Workshop	17.2	6
Assisted Living Facility[3]		
… in a chapel (used primarily by residents)	23.8	4
… in a recreation room (used primarily by residents)	26.0	6
Automotive (see “Vehicular Maintenance Area”)		
Convention Center—Exhibit Space	15.7	4
Dormitory—Living Quarters	4.2	8
Fire Station—Sleeping Quarters	2.4	6
Gymnasium/Fitness Center		
… in an exercise area	7.8	4
… in a playing area	13.0	4
Healthcare Facility		
… in an exam/treatment room	18.0	8
… in an imaging room	16.3	6
… in a medical supply room	8.0	6
… in a nursery	9.5	6
… in a nurse’s station	7.6	6
… in an operating room	26.8	6
… in a patient room	6.7	6
… in a physical therapy room	9.9	6
… in a recovery room	12.4	6
Library		
… in a reading area	11.5	4
… in the stacks	18.4	4
Manufacturing Facility		
… in a detailed manufacturing area	13.9	4
… in an equipment room	8.0	6
… in an extra-high bay area (>15.24 m floor-to-ceiling height)	11.3	4
… in a high bay area (7.62–15.24 m floor-to-ceiling height)	13.3	4
… in a low bay area (<7.62 m floor-to-ceiling height)	12.9	4
Museum		
… in a general exhibition area	11.4	6
… in a restoration room	11.0	6

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 2.4 m and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a “picking area.”

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method *(continued)* (SI)

Common Space Types[1]	LPD, W/m²	RCR Threshold
Performing Arts Theater—Dressing Room	6.6	6
Post Office—Sorting Area	10.2	4
Religious Buildings		
… in a fellowship hall	6.9	4
… in a worship/pulpit/choir area	16.5	4
Retail Facilities		
… in a dressing/fitting room	7.7	8
… in a mall concourse	11.9	4
Sports Arena—Playing Area		
… for a Class I facility	39.7	4
… for a Class II facility	25.9	4
… for a Class III facility	19.4	4
… for a Class IV facility	13.0	4
Transportation Facility		
… in a baggage/carousel Area	5.7	4
… in an airport concourse	3.9	4
… at a terminal ticket counter	8.7	4
Warehouse—Storage Area		
…for medium to bulky, palletized items	6.2	4
… for smaller, hand-carried items[5]	10.2	6

1. In cases where both a common space type and a building-area specific space type are listed, the building-area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 2.4 m and is not based on the RCR.
3. An Assisted Living Facility is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "picking area."

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

FOREWORD

In 2005, ASHRAE approved amendments to Standard 90.1 (addendum f to ASHRAE/IESNA Standard 90.1-2004) adopting new minimum energy efficiency standards for three-phase air-cooled commercial air conditioners and heat pumps below 65,000 Btu/h. These standards became effective on January 23, 2006.

On June 27, 2011, the Department of Energy (DOE) issued a final rule amending the federal minimum energy efficiency standards for the single-phase residential central air conditioners and heat pumps. This proposal harmonizes the minimum energy efficiencies of three-phase air-cooled commercial air conditioners and heat pumps less than 65,000 Btu/h with the efficiencies adopted by DOE for residential central air conditioners. The new SEERs and HSPFs will become effective on January 1, 2015.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bi to Standard 90.1-2010

Revise Tables 6.8.1A and 6.8.1B as follows (I-P and SI units, respectively).

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, air Cooled	<65,000 Btu/h[b]	All	Split System	13.0 SEER	AHRI 210/240
			Single Package	13.0 SEER (before 1/1/2015) 14 SEER (as of 1/1/2015)	
Through-the-wall (air cooled)	≤30,000 Btu/h[b]	All	Split system	12.0 SEER	
			Single Package	12.0 SEER	
Air conditioners, air cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	
	≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	
		All other	Split System and Single Package	9.8 EER 9.9 IEER	
	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	
		All other	Split System and Single Package	9.5 EER 9.6 IEER	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA.

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (I-P) ***(continued)***

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, water Cooled	<65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.5 EER (before 6/1/2011)~~ 12.1 EER ~~(as of 6/1/2011)~~ ~~11.7 IEER (before 6/1/2011)~~ 12.3 IEER ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split System and Single Package	~~11.3 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~ ~~11.5 IEER (before 6/1/2011)~~ 12.1 IEER ~~(as of 6/1/2011)~~	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.0 EER (before 6/1/2011)~~ 12.5 EER ~~(as of 6/1/2011)~~ ~~11.2 IEER (before 6/1/2011)~~ 12.5 IEER ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 12.3 EER ~~(as of 6/1/2011)~~ ~~11.0 IEER (before 6/1/2011)~~ 12.5 IEER ~~(as of 6/1/2011)~~	
	≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER ~~(before 6/1/2011)~~ 12.4 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 12.6 IEER ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 12.2 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 12.4 IEER ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA.

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (I-P) *(continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, water Cooled	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.0 EER (before 6/1/2011)~~ 12.2 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 12.4 IEER ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 12.0 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 12.2 IEER ~~(as of 6/1/2011)~~	
Air Conditioners, evaporatively cooled	<65,000 Btu/h[b]	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.5 EER (before 6/1/2011)~~ 12.1 EER ~~(as of 6/1/2011)~~ ~~11.7 IEER (before 6/1/2011)~~ 12.3 IEER ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split System and Single Package	~~11.3 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~ ~~11.5 IEER (before 6/1/2011)~~ 12.1 IEER ~~(as of 6/1/2011)~~	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.0 EER (before 6/1/2011)~~ 12.0 EER ~~(as of 6/1/2011)~~ ~~11.2 IEER (before 6/1/2011)~~ 12.2 IEER ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 11.8 EER ~~(as of 6/1/2011)~~ ~~11.0 IEER (before 6/1/2011)~~ 12.0 IEER ~~(as of 6/1/2011)~~	
	≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.0 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~) ~~11.1 IEER (before 6/1/2011)~~ 12.1 IEER ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 11.7 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 11.9 IEER ~~(as of 6/1/2011)~~	
	≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	~~11.0 EER (before 6/1/2011)~~ 11.7 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 11.9 IEER ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 11.5 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 11.7 IEER ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA.

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (I-P) *(continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Condensing units air cooled	≥135,000Btu/h			~~10.1 EER (before 6/1/2011)~~ 10.5 EER ~~(as of 6/1/2011)~~ ~~11.4 IEER (before 6/1/2011)~~ 11.8 IEER ~~(as of 6/1/2011)~~	AHRI 365
Condensing units water cooled	≥135,000Btu/h			~~13.1 EER (before 6/1/2011)~~ 13.5 EER ~~(as of 6/1/2011)~~ ~~13.6 IEER (before 6/1/2011)~~ 14.0 IEER ~~(as of 6/1/2011)~~	
Condensing units evaporatively cooled	≥135,000Btu/h			~~13.1 EER (before 6/1/2011)~~ 13.5 EER ~~(as of 6/1/2011)~~ ~~13.6 IEER (before 6/1/2011)~~ 14.0 IEER ~~(as of 6/1/2011)~~)	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA.

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air cooled (cooling mode)	<65,000 Btu/h[b]	All	Split System	13.0 SEER (before 1/1/2015) 14 SEER (as of 1/1/2015)	AHRI 210/240
			Single Packaged	13.0 SEER (before 1/1/2015) 14 SEER (as of 1/1/2015)	
Through-the-wall, air cooled	≤30,000 Btu/h[b]	All	Split System	12.0 SEER	
			Single Packaged	12.0 SEER	
Air Cooled (Cooling Mode)	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	AHRI 340/360
		All other	Split System and Single Package	10.8 EER 11.0 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 10.7 IEER	
		All other	Split System and Single Package	10.4 EER 10.5 IEER	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.6 IEER	
		All other	Split System and Single Package	9.3 EER 9.4 IEER	
Water to Air: Water Loop (cooling mode)	<17,000 Btu/h	All	86°F entering water	12.2 EER	ISO 13256-1
	≥17,000 Btu/h and <65,000 Btu/h	All	86°F entering water	13 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	86°F entering water	13 EER	
Water to Air: Ground Water (cooling mode)	<135,000 Btu/h	All	59°F entering water	18.0 EER	
Brine to Air: Ground Loop (cooling mode)	<135,000 Btu/h	All	77°F entering water	14.1 EER	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements (I-P) *(continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Water to Water: Water Loop (cooling mode)	<135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water to Water: Ground Water (Cooling Mode)	<135,000 Btu/h	All	59°F entering water	16.3 EER	ISO-13256-2
Brine to Water: Ground Loop (cooling mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	ISO-13256-2
Air cooled (heating mode)	<65,000 Btu/h[b]	—	Split System	7.7 HSPF (before 1/1/2015) 8.2 HSPF (as of 1/1/2015)	AHRI 210/240
		—	Single Package	7.7 HSPF (before 1/1/2015) 8.0 HSPF (as of 1/1/2015)	AHRI 210/240
Through-the-wall, (air cooled, heating mode)	≤30,000 Btu/h[b] (cooling capacity)	—	Split System	7.4 HSPF	AHRI 210/240
		—	Single Package	7.4 HSPF	AHRI 210/240
Air Cooled (Heating Mode)	≥65,000 Btu/h and <135,000 Btu/h (Cooling Capacity)	—	47°F db/43°F wb Outdoor Air	3.3 COP	AHRI 340/360
			17°F db/15°F wb Outdoor Air	2.25 COP	AHRI 340/360
	≥135,000 Btu/h (Cooling Capacity)	—	47°F db/43°F wb Outdoor Air	3.2 COP	AHRI 340/360
			17°F db/15°F wb Outdoor Air	2.05 COP	AHRI 340/360
Water to Air: Water Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68°F entering water	4.3 COP	ISO 13256-1
Water to Air: Ground Water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50°F entering water	3.7 COP	ISO 13256-1
Brine to Air: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.2 COP	ISO 13256-1

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (I-P) ***(continued)***

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Water to Water: Water Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	ISO 13256-2
Water to Water: Ground Water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50°F entering water	3.1 COP	
Brine to Water: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
b. Single-phase, air-cooled air conditioners <65,000 Btu/h are regulated by NAECA; SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, air Cooled	<9 kW[b]	All	Split System	3.81 $SCOP_C$	AHRI 210/240
			Single Package	3.81 $SCOP_C$ (before 1/1/2015) 4.10 $SCOP_C$ (after 1/1/2015)	
Through-the-wall (air cooled)	≤9 kW[b]	All	Split system	3.52 $SCOP_C$	
			Single Package	3.52 $SCOP_C$	
Air conditioners, air cooled	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	3.28 COP_C 3.34 ICOP	AHRI 340/360
		All other	Split System and Single Package	3.22 COP_C 3.28 ICOP	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP_C 3.28 ICOP	
		All other	Split System and Single Package	3.17 COP_C 3.22 ICOP	
	≥70 kW and <223 kW	Electric Resistance (or None)	Split System and Single Package	2.93 COP_C 2.96 ICOP	
		All other	Split System and Single Package	2.87 COP_C 2.90 ICOP	
	≥223 kW	Electric Resistance (or None)	Split System and Single Package	2.84 COP_C 2.87 ICOP	
		All other	Split System and Single Package	2.78 COP_C 2.81 ICOP	

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (SI) ***(continued)***

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, water Cooled	<19 kW	All	Split System and Single Package	3.55 COP_C 3.6 ICOP	AHRI 210/240
	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	~~3.37 COP_C (before 6/1/2011)~~ 3.55 COP_C ~~(as of 6/1/2011)~~ ~~3.43 ICOP (before 6/1/2011)~~ 3.60 ICOP ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split System and Single Package	~~3.31 COP_C (before 6/1/2011)~~ 3.49 COP_C ~~(as of 6/1/2011)~~ ~~3.37 ICOP (before 6/1/2011)~~ 3.55 ICOP ~~(as of 6/1/2011)~~	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.66 COP_C ~~(as of 6/1/2011)~~ ~~3.28 ICOP (before 6/1/2011)~~ 3.66 ICOP ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~3.17 COP_C (before 6/1/2011)~~ 3.58 COP_C ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.63 ICOP ~~(as of 6/1/2011)~~	
	≥70 kW and <223 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.63 COP_C ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.69 ICOP ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~3.17 COP_C (before 6/1/2011)~~ 3.58 COP_C ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.63 ICOP ~~(as of 6/1/2011)~~	

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (*continued*) (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air Conditioners, water Cooled	≥223 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.58 COP_C ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.63 ICOP (as of 6/1/2011	AHRI 340/360
		All other	Split System and Single Package	~~3.17 COP_C (before 6/1/2011)~~ 3.52 COP_C ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.58 ICOP ~~(as of 6/1/2011)~~	
Air Conditioners, evaporatively cooled	<19 kW[b]	All	Split System and Single Package	3.55 COP_C 3.60 ICOP	AHRI 210/240
	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	~~3.37 COP_C (before 6/1/2011)~~ 3.55 COP_C ~~(as of 6/1/2011)~~ ~~3.43 ICOP (before 6/1/2011)~~ 3.60 ICOP ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split System and Single Package	~~3.31 COP_C (before 6/1/2011)~~ 3.49 COP_C ~~(as of 6/1/2011)~~ ~~3.37 ICOP (before 6/1/2011)~~ 3.55 ICOP ~~(as of 6/1/2011)~~	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.52 COP_C ~~(as of 6/1/2011)~~ ~~3.28 ICOP (before 6/1/2011)~~ 3.58 ICOP ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~3.17 COP_C (before 6/1/2011)~~ 3.46 COP_C ~~(as of 6/1/2011)~~ ~~3.22 ICOP (before 6/1/2011)~~ 3.52 ICOP ~~(as of 6/1/2011)~~	
	≥70 kW and <223 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.49 COP_C ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.55 ICOP ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	3.17 COP_C ~~(before 6/1/2011)~~ 3.43 COP_C ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.49 ICOP ~~(as of 6/1/2011)~~	
	≥223 kW	Electric Resistance (or None)	Split System and Single Package	~~3.22 COP_C (before 6/1/2011)~~ 3.43 COP_C ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.49 ICOP ~~(as of 6/1/2011)~~	
		All other	Split System and Single Package	~~3.17 COP_C (before 6/1/2011)~~ 3.37 COP_C ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.43 ICOP ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (*continued*) (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Condensing units air cooled	≥40 kW			~~2.96 COP_C (before 6/1/2011)~~ 3.08 COP_C ~~(as of 6/1/2011)~~ ~~3.34 ICOP (before 6/1/2011)~~ 3.46 ICOP ~~(as of 6/1/2011)~~	AHRI 365
Condensing units water cooled	≥40 kW			~~3.84 COP_C (before 6/1/2011)~~ 3.96 COP_C ~~(as of 6/1/2011)~~ ~~3.99 ICOP (before 6/1/2011)~~ 4.10 ICOP ~~(as of 6/1/2011)~~	
Condensing units evaporatively cooled	≥40 kW			~~3.84 COP_C (before 6/1/2011)~~ 3.96 COP_C ~~(as of 6/1/2011)~~ ~~3.99 ICOP (before 6/1/2011)~~ 4.10 ICOP ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air cooled (cooling mode)	<19 kW[b]	All	Split System	3.81 SCOP$_c$ (before 1/1/2015) 4.10 SCOP$_c$ (as of 1/1/2015)	AHRI 210/240
			Single Packaged	3.81 SCOP$_c$ (before 1/1/2015) 4.10 SCOP$_c$ (as of 1/1/2015)	
Through-the-wall, air cooled	≤9 kW[b]	All	Split System	3.51 SCOP$_c$	
			Single Packaged	3.51 SCOP$_c$	
Air Cooled (Cooling Mode)	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP$_c$ 3.28 ICOP$_c$	AHRI 340/360
		All other	Split System and Single Package	3.16 COP$_c$ 3.22 ICOP$_c$	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	3.13 ICOP$_c$	
		All other	Split System and Single Package	3.05 COP$_c$ 3.07 ICOP$_c$	
	≥70 kW	Electric Resistance (or None)	Split System and Single Package	2.78 COP$_c$ 2.81 ICOP$_c$	
		All other	Split System and Single Package	2.72 COP$_c$ 2.75 ICOP$_c$	
Water to Air: Water Loop (cooling mode)	<5 kW	All	30°C entering water	3.57 COP$_c$	ISO 13256-1
	≥5 kW and <19 kW	All	30°C entering water	3.81 COP$_c$	
	≥19 kW and <40 kW	All	30°C entering water	3.81 COP$_c$	
Water to Air: Ground Water (cooling mode)	<40 kW	All	15°C entering water	5.27 COP$_c$	
Brine to Air: Ground Loop (cooling mode)	<40 kW	All	25°C entering water	4.13 COP$_c$	

**TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—
Minimum Efficiency Requirements (SI) *(continued)***

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Water to Water: Water Loop (cooling mode)	<40 kW	All	30°C entering water	3.10 COP_c	ISO-13256-2
Water to Water: Ground Water (Cooling Mode)	<40 kW	All	15°C entering water	4.77 COP_c	
Brine to Water: Ground Loop (cooling mode)	<40 kW	All	25°C entering water	3.55 COP_c	
Air cooled (heating mode)	<19 kW[b]	—	Split System	2.26 $SCOP_H$ (before 1/1/2015) 2.40 $SCOP_H$ (as of 1/1/2015)	AHRI 210/240
		—	Single Package	2.26 $SCOP_H$ (before 1/1/2015) 2.34 $SCOP_H$ (as of 1/1/2015)	
Through-the-wall, (air cooled, heating mode)	≤9 kW[b] (cooling capacity)	—	Split System	2.17 $SCOP_H$	
		—	Single Package	2.17 $SCOP_H$	
Air Cooled (Heating Mode)	≥19 kW and <40 kW (Cooling Capacity)	—	8.3°C db/6.1°C wb Outdoor Air	3.3 COP_H	AHRI 340/360
			–8.3°C db/–9.4°C wb Outdoor Air	2.25 COP_H	
	≥40 kW (Cooling Capacity)	—	8.3°C db/6.1°C wb Outdoor Air	3.2 COP_H	
			–8.3°C db/–9.4°C wb Outdoor Air	2.05 COP_H	
Water to Air: Water Loop (heating mode)	<40 kW (cooling capacity)	—	20°C entering water	4.3 COP_H	ISO 13256-1
Water to Air: Ground Water (heating mode)	<40 kW (cooling capacity)	—	10°C entering water	3.7 COP_H	
Brine to Air: Ground Loop (heating mode)	<40 kW (cooling capacity)	—	0°C entering fluid	3.2 COP_H	
Water to Water: Water Loop (heating mode)	<40 kW (cooling capacity)	—	20°C entering water	3.7 COP_H	ISO 13256-2
Water to Water: Ground Water (heating mode)	<40 kW (cooling capacity)	—	10°C entering water	3.1 COP_H	
Brine to Water: Ground Loop (heating mode)	<40 kW (cooling capacity)	—	0°C entering fluid	2.5 COP_H	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

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

FOREWORD

A product class for three-phase small-duct high-velocity (SDHV) air conditioners and heart pumps was first established in the 2007 version of ASHRAE/IESNA Standard 90.1. Subsequently, addendum j to Standard 90.1-2010 deleted the product class. The deletion was based on information that all SDHV produced and sold in the market place were single-phase residential products covered under the National Energy Conservation Act (NAECA). However, since the deletion of the product class, SDHV manufacturers have expressed their intention to introduce three-phase products in the near future.

This addendum re-establishes the product class for small-duct high-velocity air conditioners and heat pumps. The minimum energy efficiency levels proposed are 11 SEER for air conditioners and 11 SEER/6.8 HSPF for heat pumps, which are identical to the efficiencies established by DOE for single-phase residential SDHV products.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bj to Standard 90.1-2010

Revise Tables 6.8.1A and 6.8.1B as follows for I-P and SI, respectively.

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[b]
Air conditioners, (air-cooled)	<65,000 Btu/h[b]	All	Split System	13.0 SEER	AHRI 210/240
			Single Package	13.0 SEER	
Through-the-wall (air-cooled)	≤30,000 Btu/h[b]	All	Split system	12.0 SEER	
			Single Package	12.0 SEER	
Small-duct high-velocity (air-cooled)	<65,000 Btu/h[b]	All	Split System	11.0 SEER	
Air conditioners (air-cooled)	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	AHRI 340/360
		All other	Split System and Single Package	11.0 EER 11.2 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
		All other	Split System and Single Package	10.8 EER 11.0 IEER	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[~~a~~]	Test Procedure[~~b~~a]
Air-cooled (cooling mode)	<65,000 Btu/h[~~c~~b]	All	Split System	13.0 SEER	AHRI 210/240
			Single Packaged	13.0 SEER	
Through-the-wall (air-cooled)	≤30,000 Btu/h[b]	All	Split System	12.0 SEER	
			Single Packaged	12.0 SEER	
Single-duct high-velocity (air-cooled)	<65,000 Btu/h[b]	All	Split System	11.0 SEER	
Brine to Water: Ground Loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	
Air-cooled (heating mode)	<65,000 Btu/h[b]	—	Split System	7.7 HSPF	AHRI 210/240
		—	Single Package	7.7 HSPF	
Through-the-wall (air-cooled, heating mode)	≤30,000 Btu/h[b] (cooling capacity)	—	Split System	7.4 HSPF	
		—	Single Package	7.4 HSPF	
Small-duct high-velocity (air-cooled, heating mode)	<65,000 Btu/h[b]	—	Split System	6.8 HSPF	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (air-cooled)	<19 kW[b]	All	Split System	3.81 $SCOP_C$	AHRI 210/240
			Single Package	3.81 $SCOP_C$	
Through-the-wall (air-cooled)	≤9 kW[b]	All	Split system	3.52 $SCOP_C$	
			Single Package	3.52 $SCOP_C$	
Small-duct high-velocity (air-cooled)	<19 kW[b]	All	Split System	2.93 SCOP	
[. . .]	[. . .]	[. . .]	[. . .]	[. . .]	[. . .]
Air conditioners (air-cooled)	≥19 kW and <40 kW	Electric Resistance (or None)	Split System and Single Package	3.28 COP_C 3.34 ICOP	AHRI 340/360
		All other	Split System and Single Package	3.22 COP_C 3.28 ICOP	
	≥40 kW and <70 kW	Electric Resistance (or None)	Split System and Single Package	3.22 COP_C 3.28 ICOP	
		All other	Split System and Single Package	3.17 COP_C 3.22 ICOP	
	≥70 kW and <223 kW	Electric Resistance (or None)	Split System and Single Package	2.93 COP_C 2.96 ICOP	
		All other	Split System and Single Package	2.87 COP_C 2.90 ICOP	
	≥223 kW	Electric Resistance (or None)	Split System and Single Package	2.84 COP_C 2.87 ICOP	
		All other	Split System and Single Package	2.78 COP_C 2.81 ICOP	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, COP_c values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements (SI Units)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air-cooled (cooling mode)	<19 kW[b]	All	Split System	3.81 $SCOP_c$	AHRI 2010/240
			Single Packaged	3.81 $SCOP_c$	
Through-the-wall (air-cooled)	≤9 kW[b]	All	Split System	3.51 $SCOP_c$	
			Single Packaged	3.51 $SCOP_c$	
<u>Single-duct high-velocity (air-cooled)</u>	<u><19 kW[b]</u>	<u>All</u>	<u>Split System</u>	<u>2.93 $SCOP_c$</u>	
[. . .]	[. . .]	[. . .]	[. . .]	[. . .]	[. . .]
Air-cooled (heating mode)	<19 kW[b]	—	Split System	2.26 $SCOP_H$	AHRI 210/240
		—	Single Package	2.26 $SCOP_H$	
Through-the-wall (air-cooled, heating mode)	≤9 kW[b] (cooling capacity)	—	Split System	2.17 $SCOP_H$	
		—	Single Package	2.17 $SCOP_H$	
<u>Small-duct high-velocity (air-cooled, heating mode)</u>	<u><19 kW[b]</u>	<u>—</u>	<u>Split System</u>	<u>2.0 $SCOP_H$</u>	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, COP_c values are those set by NAECA

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

FOREWORD

In 2009, ASHRAE amended the minimum energy efficiency standards for standard-sized packaged terminal equipment to be consistent with the minimum federal energy efficiencies established by the Department of Energy (DOE). These minimum standards will become effective on October 8, 2012. When developing these standards, DOE set the minimum EERs for PTACs are a lower level than PTHPs.

This proposal amends the minimum energy efficiency requirements for standard-size packaged terminal air conditioners and raises the minimum EER to the same level as the packaged terminal heat pumps. This new minimum efficiency will become effective on January 1, 2015.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bk to Standard 90.1-2010

Revise Table 6.8.1D as follows for I-P units.

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
PTAC (cooling mode) standard size	All capacities	95°F db outdoor air	~~12.5 – (0.213 × Cap/1000)[c] EER (before 10/08/2012)~~ 13.8 – (0.300 × Cap/1000)[c] EER (~~as of 10/08/2012~~before 1/1/2015) 14.0 – (0.300 × Cap/1000)[c] EER (as of 1/1/2015)	AHRI 310/380

Revise Table 6.8.1D as follows for SI units.

TABLE 6.8.1D Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
PTAC (cooling mode) standard size	All capacities	35°C db outdoor air	~~3.66 – (0.213 × Cap/1000)[c] COP~~$_{c}$ ~~(before 10/08/2012)~~ 4.04 – (0.300 × Cap/1000)[c] EER (~~as of 10/08/2012~~before 1/1/2015) 4.10 – (0.300 × Cap/1000)[c] EER (as of 1/1/2015)	AHRI 310/380

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

FOREWORD

Chapter 11 and Appendix G require the user to remove fan energy from equipment where the fan energy is included in the energy efficiency rating of the equipment. A method for removing the fan energy was not previously included in the standard. This addendum includes a methodology for removing the fan energy from packaged equipment efficiency ratings. This methodology is consistent with that currently in use by other codes and guidelines such as the State of California, Title 24, and the New Buildings Institute, Comnet. The inclusion of this methodology is necessary for maintaining consistent baseline building packaged equipment efficiency ratings between all users.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bl to Standard 90.1-2010

Revise Section 11.3.2 as follows (I-P units).

11.3.2 HVAC Systems.

[. . .]

c. Where ~~efficiency ratings, such as IEER and ICOP, include fan energy, the descriptor shall be broken down into its components~~ efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy from the efficiency rating. For Budget System Types 3, 4, 6, 9, and 11, calculate the minimum $COP_{nfcooling}$ and $COP_{nfheating}$ using the equation for the applicable performance rating as indicated in Tables 6.8.1A–D. Where a full- and part-load efficiency rating is provided in Tables 6.8.1, the full-load equation below shall be used:

$$COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$$

$$COP_{nfcooling} = -0.0076 \times SEER^2 + 0.3796 \times SEER$$

$$COP_{nfheating} = 1.48E\text{-}7 \times COP_{47} \times Q + 1.062 \times COP_{47}$$
(applies to heat-pump heating efficiency only)

$$COP_{nfheating} = -0.0296 \times HSPF^2 + 0.7134 \times HSPF$$

where $COP_{nfcooling}$ and $COP_{nfheating}$ are the packaged HVAC equipment cooling and heating energy efficiency, respectively, to be used in the budget building design, which excludes supply fan power, and Q is the AHRI-rated cooling capacity in Btu/h.

EER, SEER, COP, and HSPF shall be at AHRI test conditions. ~~so that supply f~~Fan energy ~~can~~ shall be modeled separately according to Section 11.3.2(h). Supply and return/relief system fans shall be modeled as operating at least whenever the spaces served are occupied except as specifically noted in Table 11.3.2A.

Revise Table 11.3.1 as follows (I-P units).

TABLE 11.3.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

No.	Proposed Building Design (Column A) Design Energy Cost (DEC)	Budget Building Design (Column B) Energy Cost Budget (ECB)
[. . .]		
10.	**HVAC Systems**	
	The HVAC system type and all related performance parameters, such as equipment capacities and efficiencies, in the proposed building design shall be determined as follows: a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1, if required by the simulation model. Where efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy from the efficiency rating in the budget building design. The equations in Section 11.3.2 shall not be used in the proposed building. The proposed building HVAC system shall be modeled using manufacturers' full- and part-load data for the HVAC system without fan power. c. Where no heating system exists or no heating system has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical to the system modeled in the budget building design. d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal block. The system characteristics shall be identical to the system modeled in the budget building design.	The HVAC system type and related performance parameters for the budget building design shall be determined from Figure 11.3.2, the system descriptions in Table 11.3.2A and accompanying notes, and in accord with rules specified in Section 11.3.2 (a)–(j).
[. . .]		

Revise Table 11.3.2 as follows (I-P units).

TABLE 11.3.2A Budget System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type
1	VAV with parallel fan-powered boxes[a]	VAV[d]	Chilled water[e]	Electric resistance
2	VAV with reheat[b]	VAV[d]	Chilled water[e]	Hot-water fossil fuel boiler[f]
3	Packaged VAV with parallel fan-powered boxes[a]	VAV[d]	Direct expansion[c]	Electric resistance
4	Packaged VAV with reheat[b]	VAV[d]	Direct expansion[c]	Hot-water fossil fuel boiler[f]
5	Two-pipe fan-coil	~~Constant Volume~~ Single- or two-speed fan [i,j]	Chilled water[e]	Electric resistance
6	Water-source heat pump	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Electric heat pump and boiler[g]
7	Four-pipe fan-coil	~~Constant Volume~~ Single- or two-speed fan [i,j]	Chilled water[e]	Hot-water fossil fuel boiler[f]
8	Packaged terminal heat pump	~~Constant Volume~~ Single-speed fan[i]	Direct expansion[c]	Electric heat pump[h]
9	Packaged rooftop heat pump	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Electric heat pump[h]
10	Packaged terminal air conditioner	~~Constant Volume~~ Single-speed fan[i]	Direct expansion[c]	Hot-water fossil fuel boiler[f]
11	Packaged rooftop air conditioner	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Fossil fuel furnace

[. . .]

i. **~~Constant volume~~Fan System Operation:** Fans shall be controlled in the same manner as in the proposed building design; i.e., fan operation whenever the space is occupied or fan operation cycled on calls for heating and cooling. ~~If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall not be modeled explicitly.~~

j. **Fan Speed Control:** Fans shall operate as one- or two-speed as required by Section 6.5.3.2, regardless of the fan speed control used in the proposed building.

Revise Section G3.1.2.1 as follows (I-P units).

G3.1.2.1 Equipment Efficiencies. All HVAC equipment in the baseline building design shall be modeled at the minimum efficiency levels, both part load and full load, in accordance with Section 6.4. Where ~~efficiency ratings, such as IEER and ICOP, include fan energy, the descriptor shall be broken down into its components~~ efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy from the efficiency rating.. For Baseline HVAC Systems 1, 2, 3, 4, 5, and 6, calculate the minimum $COP_{nfcooling}$ and $COP_{nfheating}$ using the equation for the applicable performance rating as indicated in Tables 6.8.1A–D. Where a full- and part-load efficiency rating is provided in Tables 6.8.1A–D, the full-load equation below shall be used:

$$COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$$

$$COP_{nfcooling} = -0.0076 \times SEER^2 + 0.3796 \times SEER$$

$$COP_{nfheating} = 1.48E\text{-}7 \times COP_{47} \times Q + 1.062 \times COP_{47}$$
(applies to heat-pump heating efficiency only)

$$COP_{nfheating} = -0.0296 \times HSPF^2 + 0.7134 \times HSPF$$

where $COP_{nfcooling}$ and $COP_{nfheating}$ are the packaged HVAC equipment cooling and heating energy efficiency, respectively, to be used in the baseline building, which excludes supply fan power, and Q is the AHRI-rated cooling capacity in Btu/h.

EER, SEER, COP, and HSPF shall be at AHRI test conditions. ~~so that supply f~~Fan energy ~~can~~ shall be modeled separately according to Section G3.1.2.10.

Revise Table G3.1 as follows (I-P units)

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No. Proposed Building Performance	Baseline Building Performance
[. . .]	
10. HVAC Systems	
The HVAC system type and all related performance parameters in the proposed design, such as equipment capacities and efficiencies, shall be determined as follows: a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. <u>Where efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy from the efficiency rating in the baseline building design. The equations in Section G3.1.2.1 shall not be used in the proposed building. The proposed building HVAC system shall be modeled using manufacturers' full- and part-load data for the HVAC system without fan power.</u> c. Where no heating system exists or no heating system has been specified, the heating system classification shall be assumed to be electric, and the system characteristics shall be identical to the system modeled in the baseline building design. d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be identical to the system modeled in the baseline building design. **Exception to d:** Spaces using baseline HVAC system types 9 and 10.	The HVAC system(s) in the baseline building design shall be of the type and description specified in Section G3.1.1, shall meet the general HVAC system requirements specified in Section G3.1.2, and shall meet any system-specific requirements in Section G3.1.3 that are applicable to the baseline HVAC system type(s).
[. . .]	

Revise Section 11.3.2 as follows (SI units).

11.3.2 HVAC Systems.

[. . .]

c. Where efficiency ratings~~, such as IEER and ICOP,~~ include supply fan energy, ~~descriptor shall be broken down into its components~~ the efficiency ratings shall be adjusted to remove the supply fan energy. For Budget System Types 3, 4, 6, 9, and 11, calculate the minimum $COP_{nfcooling}$ and $COP_{nfheating}$ using the equation for the applicable performance rating as indicated in Tables 6.8.1A–D. Where a full- and part-load efficiency rating is provided in Tables 6.8.1A–D, the full-load equation below shall be used:

$$COP_{nfcooling} = 9.13E\text{-}4 \times COP_C \times Q + 1.15 \times COP_C$$

$$COP_{nfcooling} = -0.0885 \times SCOP_C^2 + 1.295 \times SCOP_C$$

(applies to cooling efficiency only)

$$COP_{nfheating} = 5.05E\text{-}4 \times COP_{H8.3} \times Q + 1.062 \times COP_{H8.3}$$

(applies to heat-pump heating efficiency only)

$$COP_{nfheating} = -0.3446 \times SCOP_H^2 + 2.434 \times SCOP_H$$

where $COP_{nfcooling}$ and $COP_{nfheating}$ are the packaged HVAC equipment cooling and heating energy efficiency, respectively, to be used in the budget building design, which excludes supply fan power, and Q is the AHRI-rated cooling capacity in kW.

COP_C, $SCOP_C$, $SCOP_{H8.3}$, and $SCOP_H$ shall be at AHRI test conditions. ~~so that supply f~~Fan energy ~~can~~ shall be modeled separately according to Section 11.3.2h. Supply and return/relief system fans shall be modeled as operating at least whenever the spaces served are occupied except as specifically noted in Table 11.3.2A.

Revise Table 11.3.1 as follows (SI units).

TABLE 11.3.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

No.	Proposed Building Design (Column A) Design Energy Cost (DEC)	Budget Building Design (Column B) Energy Cost Budget (ECB)
[. . .]		
10.	**HVAC Systems**	
	The HVAC system type and all related performance parameters, such as equipment capacities and efficiencies, in the proposed building design shall be determined as follows: a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1, if required by the simulation model. Where efficiency ratings include supply fan energy, the efficiency rating shall be adjusted to remove the supply fan energy in the budget building design. The equations in Section 11.3.2 shall not be used in the proposed building. The proposed building HVAC system shall be modeled using manufacturer's full- and part-load data for the HVAC system without fan power. c. Where no heating system exists or no heating system has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical to the system modeled in the budget building design. d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal block. The system characteristics shall be identical to the system modeled in the budget building design.	The HVAC system type and related performance parameters for the budget building design shall be determined from Figure 11.3.2, the system descriptions in Table 11.3.2A and accompanying notes, and in accord with rules specified in Section 11.3.2 (a)–(j).
[. . .]		

Revise Table 11.3.2 as follows (SI units).

TABLE 11.3.2A Budget System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type
1	VAV with parallel fan-powered boxes[a]	VAV[d]	Chilled water[e]	Electric resistance
2	VAV with reheat[b]	VAV[d]	Chilled water[e]	Hot-water fossil fuel boiler[f]
3	Packaged VAV with parallel fan-powered boxes[a]	VAV[d]	Direct expansion[c]	Electric resistance
4	Packaged VAV with reheat[b]	VAV[d]	Direct expansion[c]	Hot-water fossil fuel boiler[f]
5	Two-pipe fan-coil	~~Constant Volume~~ Single- or two-speed fan [i,j]	Chilled water[e]	Electric resistance
6	Water-source heat pump	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Electric heat pump and boiler[g]
7	Four-pipe fan-coil	~~Constant Volume~~ Single- or two-speed fan [i,j]	Chilled water[e]	Hot-water fossil fuel boiler[f]
8	Packaged terminal heat pump	~~Constant Volume~~ Single-speed fan[i]	Direct expansion[c]	Electric heat pump[h]
9	Packaged rooftop heat pump	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Electric heat pump[h]
10	Packaged terminal air conditioner	~~Constant Volume~~ Single-speed fan[i]	Direct expansion[c]	Hot-water fossil fuel boiler[f]
11	Packaged rooftop air conditioner	~~Constant Volume~~ Single- or two-speed fan [i,j]	Direct expansion[c]	Fossil fuel furnace

[. . .]

i. **~~Constant volume~~Fan System Operation:** Fans shall be controlled in the same manner as in the proposed building design; i.e., fan operation whenever the space is occupied or fan operation cycled on calls for heating and cooling. ~~If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall not be modeled explicitly.~~

j. **Fan Speed Control:** Fans shall operate as one or two speed as required by Section 6.5.3.2 regardless of the fan speed control used in the proposed building.

Revise Section G3.1.2.1 as follows (SI units).

G3.1.2.1 Equipment Efficiencies. All HVAC equipment in the baseline building design shall be modeled at the minimum efficiency levels, both part load and full load, in accordance with Section 6.4. Where efficiency ratings~~, such as IEER and ICOP,~~ include fan supply energy, ~~the descriptor shall be broken down into its components~~ the efficiency rating shall be adjusted to remove the supply fan energy. For Baseline HVAC Systems 1, 2, 3, 4, 5, and 6, calculate the minimum $COP_{nfcooling}$ and $COP_{nfheating}$ using the equation for the applicable performance rating as indicated in Tables 6.8.1A–D. Where a full- and part-load efficiency rating is provided in Table 6.8.1, the full-load equation below shall be used:

$$COP_{nfcooling} = 9.13E\text{-}4 \times COP_C \times Q + 1.15 \times COP_C$$

$$COP_{nfcooling} = -0.0885 \times SCOP_C^2 + 1.295 \times SCOP_C$$

(applies to cooling efficiency only)

$$COP_{nfheating} = 5.05E\text{-}4 \times COP_{H8.3} \times Q + 1.062 \times COP_{H8.3}$$

(applies to heat-pump heating efficiency only)

$$COP_{nfheating} = -0.3446 \times SCOP_H^2 + 2.434 \times SCOP_H$$

where $COP_{nfcooling}$ and $COP_{nfheating}$ are the packaged HVAC equipment cooling and heating energy efficiency, respectively, to be used in the baseline building, which excludes supply fan power, and Q is the AHRI-rated cooling capacity in kW.

COP_C, $SCOP_C$, $COP_{H8.3}$, and $SCOP_H$ shall be at AHRI test conditions. ~~so that supply f~~Fan energy ~~can~~ shall be modeled separately according to Section G3.1.2.10.

Revise Table G3.1 as follows (SI units)

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

<table>
<tr><th>No.</th><th>Proposed Building Performance</th><th>Baseline Building Performance</th></tr>
<tr><td colspan="3">[. . .]</td></tr>
<tr><td>10.</td><td colspan="2">HVAC Systems</td></tr>
<tr><td colspan="2">The HVAC system type and all related performance parameters in the proposed design, such as equipment capacities and efficiencies, shall be determined as follows:
a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies.
b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. Where efficiency ratings include supply fan energy, the efficiency rating <u>shall be adjusted to remove the supply fan energy in the baseline building design. The equations in Section G3.1.2.1 shall not be used in the proposed building. The proposed building HVAC system shall be modeled using manufacturer's full- and part-load data for the HVAC system without fan power.</u>
c. Where no heating system exists or no heating system has been specified, the heating system classification shall be assumed to be electric, and the system characteristics shall be identical to the system modeled in the baseline building design.
d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be identical to the system modeled in the baseline building design.
Exception to d: Spaces using baseline HVAC system types 9 and 10.</td><td>The HVAC system(s) in the baseline building design shall be of the type and description specified in Section G3.1.1, shall meet the general HVAC system requirements specified in Section G3.1.2, and shall meet any system-specific requirements in Section G3.1.3 that are applicable to the baseline HVAC system type(s).</td></tr>
<tr><td colspan="3">[. . .]</td></tr>
</table>

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

FOREWORD

Submetering requirements were added to ASHRAE/IES Standard 90.1-2010 through Addendum bz. The proposed addendum expands the submetering requirements to cover all fuels that are used by a building. This will ensure that the building owners and operators receive information about all of the energy being used by building equipment.

The requirements were changed to be more appropriate for Standard 90.1-2010. The current requirements in Addendum bz are significantly more stringent than the submetering requirements in ASHRAE/USGBC/IES Standard 189.1 for green buildings. In addition, there are cases where the submetering requirements would not be cost justified, due to the number of submeters required, associated installation costs, and potentially low-energy cost savings.

By focusing the metering requirements on buildings in Standard 90.1, the proposed addendum will ensure that the requirement is cost effective and will result in energy savings, especially in multi-building sites.

By requiring that all major forms of energy are metered, the proposed addendum will ensure that all opportunities for all types of energy and cost savings are addressed.

By making these changes, the standard will prevent situations where hundreds of submeters are installed at a significant cost, especially for major renovations at existing buildings (e.g., hotels and motels with hundreds of fan-coil units, PTACs, rooftop units, exhaust fans, etc.) and that are likely not to be cost effective.

This proposal was reviewed by the ASHRAE Mechanical Subcommittee and the Lighting Subcommittee, since the meters would be receiving and reporting data from mechanical as well as lighting equipment in a building.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bn to Standard 90.1-2010

Revise Section 8 as follows (I-P and SI units).

8.4.3 Electrical Energy Monitoring

8.4.~~2~~3.1 Monitoring. Measurement devices shall be installed in new buildings to monitor the electrical energy use for each of the following separately:

a. Total electrical energy
b. HVAC systems
c. Interior lighting
d. Exterior lighting
e. Receptacle circuits

For buildings with tenants, these systems shall be separately monitored for the total building and (excluding shared systems) for each individual tenant.

Exception: Up to 10% of the load for each of the categories (b) through (e) shall be allowed to be from other electrical loads.

8.4.~~2~~3.2 Recording and Reporting. The electrical energy usage for all loads specified in 8.4.3.1 shall be recorded a minimum of every 15 minutes and reported at least hourly, daily, monthly, and annually. The data for each tenant space shall be made available to that tenant. The system shall be capable of maintaining all data collected for a minimum of 36 months.

Exceptions to 8.4.3:

a. Buildings ~~or additions~~ less than ~~10,000~~ 25,000 ft^2 (~~929~~ 2322 m^2)
b. Individual tenant spaces less than ~~5,000~~ 10,000 ft^2 (~~465~~ 929 m^2)
c. Dwelling units.
d. Residential buildings with less than 10,000 ft^2 (929 m^2) of common area.
e. Critical and Equipment branches of NEC Article 517
f. Hotels, motels, and restaurants

Revise Section 10 as follows (I-P and SI units).

10.4 Mandatory Provisions

[. . .]

10.4.4 Whole-Building Energy Monitoring. Measurement devices shall be installed at the building site to monitor the energy use of each new building.

10.4.4.1 Monitoring. Measurement devices shall be installed to monitor the building use of the following types of energy supplied by a utility, energy provider, or plant that is not within the building:

a. Natural gas
b. Fuel oil
c. Propane
d. Steam
e. Chilled water
f. Hot water

10.4.4.2 Recording and Reporting. The energy use of each building on the building site shall be recorded at a minimum of every 60 minutes and reported at least hourly, daily, monthly, and annually. The system shall be capable of maintaining all data collected for a minimum of 36 months and creating user reports showing at least hourly, daily, monthly, and annual energy consumption and demand.

Exceptions to 10.4.4:

a. Buildings or additions less than 25,000 ft^2 (2322 m^2)

b. Individual tenant spaces less than 10,000 ft^2 (929 m^2)

c. Dwelling units

d. Residential buildings with less than 10,000 ft^2 (929 m^2) of common area

e. Fuel used for on-site emergency equipment

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FOREWORD

This proposed addendum adds a requirement for the use of gas-condensing service water heaters in newly constructed buildings. Additionally, the proposed addendum makes several changes to Table 7.8 to reflect current federal energy regulations for electric water heaters, to utilize the new ASHRAE Standard 146 heat-pump pool heater standard, and to increase the minimum efficiency for certain oil storage water heaters from 78% to 80%.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bo to Standard 90.1-2010

Modify Section 7 as follows (I-P and SI units).

7.5.3 Buildings with High Capacity Service Water Heating Systems. New buildings with gas service hot-water systems with a total installed gas water-heating input capacity of 1,000,000 Btu/h (29 kW) or greater, shall have gas service water-heating equipment with a minimum thermal efficiency (E_t) of 90%. Multiple units of gas water-heating equipment are allowed to meet this requirement if the water-heating input provided by equipment with thermal efficiency (E_t) above and below 90% provides an input capacity-weighted average thermal efficiency of at least 90%.

The requirements of Section 7.5.3 are effective on July 30, 2015.

Exceptions:

a. Where 25% of the annual service water-heating requirement is provided by site-solar or site-recovered energy.
b. Water heaters installed in individual dwelling units.
c. Individual gas water heaters with input capacity not greater than 1,000,000 Btu/h (29 kW).

Modify Table 7.8 as follows (I-P and SI units).

TABLE 7.8 Performance Requirements for Water Heating Equipment

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required[a]	Test Procedure[b,c]
Electric water heaters	≤12 kW	Resistance ≥20 gal	0.97–0.00132 V EF	DOE 10 CFR Part 430
	>12 kW[e]	Resistance ³20 gal	~~20 + 35 √V SL, Btu/h~~ 0.3 + 27/V_m %/h	Section G.2 of ANSI Z21.10.3
	≤24 Amps and ≤250 Volts	Heat Pump	0.93–0.00132 V EF	DOE 10 CFR Part 430
Gas storage water heaters	≤75,000 Btu/h	≥20 gal	0.67–0.0019 V EF	DOE 10 CFR Part 430
	>75,000 Btu/h[f]	<4000 (Btu/h)/gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Gas instantaneous water heaters	>50,000 Btu/h and <200,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.62–0.0019V EF	DOE 10 CFR Part 430
	≥200,000 Btu/h[d,f]	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Section G.1 and G.2 of ANSI Z21.10.3
	≥200,000 Btu/h[f]	≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	
Oil storage water heaters	≤105,000 Btu/h	≥20 gal	0.59–0.0019V EF	DOE 10 CFR Part 430
	>105,000 Btu/h	<4000 (Btu/h)/gal	~~78~~80% E_t (Q/800 + 110 √V) SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Oil instantaneous water heaters	≤210,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	0.59–0.0019V EF	DOE 10 CFR Part 430
	>210,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	80% E_t	Section G.1 and G.2 of ANSI Z21.10.3
	>210,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	
Hot-water supply boilers, gas and oil[f]	≥300,000 Btu/h and <12,500,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	80% E_t	
Hot-water supply boilers, gas[f]		≥4000 (Btu/h)/gal and ≥10 gal	80% E_t (Q/800 + 110 √V) SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Hot-water supply boilers, oil		≥4000 (Btu/h)/gal and ≥10 gal	78% E_t (Q/800 + 110 √V) SL, Btu/h	
Pool heaters, oil and gas	All		78% E_t	ASHRAE 146
Heat pump pool heaters	All	~~50°F db 44.2°F wb Outdoor Air 80.0°F Entering Water~~ (~~10.0°C db 6.78°C wb Outdoor air 26.7°C Entering water~~)	4.0 COP	ASHRAE ~~1160~~146
Unfired storage tanks	All		R-12.5	(None)

a. Energy factor (EF) and thermal *efficiency* (E_t) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h. V_m is the measured volume in the tank

b. Section 12 contains a complete specification, including the year version, of the referenced test procedure.

c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency" and Section G.2 is titled "Test Method for Measuring Standby Loss."

d. Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures of 180°F or higher.

e. Electric water heaters with input rates below 12 kW must comply with these requirements if the water heater is designed to heat water to temperatures of 180°F (82.2°C) or higher.

f. Refer to Section 7.5.3 for additional requirements for gas storage and instantaneous water heaters and gas hot water supply boilers.

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FOREWORD

Evaporatively cooled heat rejection devices are key components of the most efficient refrigeration and HVAC systems on the market. Currently, the minimum efficiencies for both open- and closed-circuit cooling towers are listed in ASHRAE/IES Standard 90.1-2010. This addendum proposes to add minimum efficiencies for evaporative condensers used in ammonia-based refrigeration systems. Evaporative condensers are utilized in cold-storage warehouses, food processing facilities, supermarkets, industrial processes, and, to a limited extent, HVAC systems. In addition to being energy-efficient heat-rejection devices, evaporative condensers increase the energy efficiency of the entire refrigeration system by enabling a much lower condensing temperature, and thus lower compressor lift, as compared to air-cooled designs.

The minimum efficiency levels for both axial fan and centrifugal fan units established in this proposal are intended to eliminate an estimated 5% of the least-efficient models from the market for ammonia systems (note that the majority of evaporative condensers are used with ammonia systems). This change will signal stakeholders in these industries of the new requirements and encourage manufacturers to develop more energy-efficient designs in the future. Efforts underway in the industry to foster an independent, third-party certification program for evaporative condensers, which has proven extremely successful for both open- and closed-circuit cooling towers, would also be supported. In addition, the evaporative condenser manufacturers have spent substantial capital for the construction and operation of dedicated refrigeration laboratories that can test full-scale condensers in support of this certification effort, as well as the development of innovative new designs.

As part of this addendum, the Cooling Technology Institute (CTI) standard, CTI ATC-106-11, Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers*, has been added to Section 12, "Normative References." Though not associated directly with the addition of evaporative condensers to Table 6.8.1G, CTI ATC-105S-11,* Acceptance Test Code for Closed Circuit Cooling Towers*, and CTI STD-201-11,* Standard for Thermal Performance Certification of Evaporative Heat Transfer Equipment*, were also reviewed and found to be still relevant to ASHRAE Standard 90.1, so the revision dates have been updated appropriately in Section 12. In addition, "R-22 test fluid" was deleted from the rating condition for air-cooled condensers to comply with the new rating in AHRI 460, which now applies to all refrigerants.*

Note that some changes to Table 6.8.1G made by addendum az are included here. To see those changes, please refer to addendum az.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bp to Standard 90.1-2010

Revise Table 6.8.1G as follows (I-P and SI units).

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c,d,f]	Test Procedure[e]
Propeller or axial fan open-circuit cooling towers	All	95°F (35.0°C) entering water 85°F (29.4°C) leaving water 75°F (23.9°C) entering wb	≥40.2 gpm/hp (3.23 L/s·kW)	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	95°F (35.0°C) entering water 85°F (29.4°C) leaving water 75°F (23.9°C) entering wb	≥20.0 gpm/hp (1.7 L/s·kW)	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	102°F (38.9°C) entering water 90°F (32.2°C) leaving water 75°F (23.9°C) entering wb	≥14.0 gpm/hp (1.18 L/s·kW)	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	102°F (38.9°C) entering water 90°F (32.2°C) leaving water 75°F (23.9°C) entering wb	≥7.0 gpm/hp (0.59 L/s·kW)	CTI ATC-105S and CTI STD-201
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F (60°C) entering gas temperature 96.3°F (35.7°C) condensing temperature 75°F (23.9°C) entering wb	≥134,000 Btu/h·hp (≥ 52.6 COP)	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F (60°C) entering gas temperature 96.3°F (35.7°C) condensing temperature 75°F (23.9°C) entering wb	≥110,000 Btu/h·hp (≥ 43.2 COP)	CTI ATC-106
Air-cooled condensers	All	125°F (52°C) condensing temperature ~~R-22 test fluid~~ 190°F (88°C) entering gas temperature 15°F (8°C) subcooling 95°F (35°C) entering db	≥176,000 Btu/h·hp (69 COP)	AHRI 460

a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan motor nameplate power.
b. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
d. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure. The certification requirements do not apply to field-erected cooling towers.
e. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections.
f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project-specific accessories and/or options included in the capacity of the cooling tower.
g. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table, divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

Modify Section 12 as follows (SI and I-P units).

12. NORMATIVE REFERENCES

Reference	Title
[. . .]	
Cooling Technology Institute, 2611 FM 1960 West, Suite A-101, Houston, TX 77068-3730; P.O. Box 73383, Houston, TX 77273-3383	
CTI ATC-105 (00)	Acceptance Test Code for Water Cooling Towers
CTI ATC-105S (~~96~~11)	Acceptance Test Code for Closed-Circuit Cooling Towers
CTI ATC-106 (11)	Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers
CTI STD-201 (~~09~~11)	Standard for Thermal Performance Certification of Evaporative Heat Transfer Equipment
[. . .]	

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FOREWORD

With the approval of Addendum aq to ASHRAE/IES Standard 90.1-2007, ASHRAE can now add requirements for some of the process and plug loads within a building. Previous ASHRAE 90.1-2010 addenda established minimum efficiency requirements for some equipment and some operational parameter limits. This addendum adds to these operational and/or application requirements. Additionally, a new section (Section 6.4.6) was created for refrigerated display cases. The economic analysis for the items addressed in this addendum indicate a scalar (payback) of 0.7 to 4.6.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bq to Standard 90.1-2010

Revise Section 3.2 as follows for I-P and SI units.

3.2 Definitions

bubble point: the refrigerant liquid saturation temperature at a specified pressure.

refrigerant dew point: the refrigerant vapor saturation temperature at a specified pressure.

low-temperature refrigeration system: systems for maintaining food product in ~~a~~ its frozen state in refrigeration applications.

medium temperature refrigeration systems: systems for maintaining food product above its ~~freezing~~ frozen state in refrigeration applications.

Revise Section 3.3 as follows for I-P and SI units.

3.3 Abbreviations and Acronyms

HVACR heating, ventilating, air conditioning, and refrigeration

Revise Section 6.4.5 as follows for I-P and SI units.

6.4.5 *Walk-in Coolers* and *Freezers*. Site-constructed or site-assembled *walk-in coolers* and *freezers* shall conform to the following requirements:

a. Shall be equipped with automatic door closers that firmly close walk-in doors that have been closed to within 1 in. of full closure.

Exception to Section 6.4.5a: Doors wider than 3 ft 9 in. or taller than 7 ft.

b. Doorways shall have strip doors (curtains), spring-hinged doors, or other method of minimizing infiltration when doors are open.

c. *Walk-in coolers* shall contain wall, ceiling, and door insulation of at least R-25 and *walk-in freezers* at least R-32.

Exception to Section 6.4.5c: Glazed portions of doors or structural members.

d. *Walk-in freezers* shall contain floor insulation of at least R-28.

e. Evaporator fan motors that are less than 1 HP and less than 460 V shall use electronically commutated motors (brushless direct current motors) or three-phase motors.

f. Lights shall use light sources with an efficacy of 40 lm/W or more, including ballast losses (if any). Light sources with an efficacy of less than 40 lm/W, including ballast losses (if any), may be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the *walk-in cooler* or *walk-in freezer* is not occupied by people.

g. Transparent reach-in doors for *walk-in freezers* and windows in *walk-in freezer* doors shall be of triple-pane glass, either filled with inert gas or with heat-reflective treated glass.

h. Transparent reach-in doors for *walk-in coolers* and windows in *walk-in cooler* doors shall be double-pane glass with heat-reflective treated glass and gas filled, or triple-pane glass, either filled with inert gas filled or with heat-reflective treated glass.

i. Antisweat heaters without antisweat heater controls shall have a total door rail, glass, and frame heater power draw of less than or equal to 7.1 W/ft^2 of door opening for *walk-in freezers*, and 3 W/ft^2 of door opening for *walk-in coolers*.

j. Antisweat heater controls shall reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

k. Condenser fan motors that are less than 1 HP shall use electronically commutated motors, permanent split capacitor-type motors or three-phase motors.

l. All walk-in freezers shall incorporate temperature-based defrost termination control with a time limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.

Exception: Walk-in coolers and walk-in freezers combined in a single enclosure greater than 3000 ft^2.

6.4.6 Refrigerated Display Case

a. All refrigerated display cases shall conform to Section 6.4.1.1, “Minimum Equipment Efficiencies,” Tables 6.8.1A through 6.8.1M.

b. Lighting in refrigerated display cases and glass doors installed on walk-in coolers and freezers shall be controlled by one of the following:

   1. Automatic time-switch controls to turn off lights during nonbusiness hours. Timed overrides for display cases or walk-in coolers and freezers may be

used to turn the lights on for up to one hour and shall automatically time out to turn the lights off.

2. Motion sensor controls on each display case or walk-in door section that reduce lighting power by at least 50% within three minutes after the area within the sensor range is vacated.

c. All low-temperature display cases shall incorporate temperature-based defrost termination control with a time-limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.

d. Antisweat heater controls shall reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

6.5.10 Refrigeration Systems. Refrigeration systems that are comprised of refrigerated display cases, *walk-in coolers* or *walk-in freezers* connected to remote compressors, ~~and~~ remote condensers, or remote condensing units~~, not in a *condensing unit*,~~ shall meet the requirements of Sections 6.5.10.1 through 6.5.10.2.

Exception: Systems utilizing transcritical refrigeration cycle or ammonia refrigerant.

6.5.10.1 Condensers Serving Refrigeration Systems. Fan-powered condensers shall conform to the following requirements:

a. Design *saturated condensing temperatures* for air-cooled condensers shall be less than or equal to the design dry-bulb temperature plus 10°F for *low temperature refrigeration systems*, and less than or equal to the design dry-bulb temperature plus 15°F for *medium temperature refrigeration systems*.

1. *Saturated condensing temperature* for blend refrigerants shall be determined using the average of liquid and vapor temperatures as converted from the condenser drain pressure.

b. Condenser fan motors that are less than 1 HP shall use electronically commutated motors, permanent split capacitor-type motors or three-phase motors.

c. All condenser fans for air-cooled condensers, evaporatively cooled condensers, air- or water-cooled fluid coolers or cooling towers shall incorporate one of the following continuous variable speed fan control approaches and shall reduce fan motor demand to no more than 30% of design wattage at 50% of design air volume.

1. Refrigeration system condenser control for air-cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry-bulb temperature.

2. Refrigeration system condenser control for evaporatively cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient wet-bulb temperature.

c. Multiple fan condensers shall be controlled in unison.

d. The minimum condensing temperature setpoint shall be no greater than 70°F (21.1°C).

6.5.10.2 ~~Refrigeration System Design~~ Compressor Systems. Refrigeration compressor systems shall conform to the following requirements. ~~be designed for minimum *saturated condensing temperature* set point less than or equal to 70°F~~.

a. Compressors and multiple-compressor systems suction groups shall include control systems that use floating suction pressure control logic to reset the target suction pressure temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

Exceptions:

1. Single compressor systems that do not have variable capacity capability.

2. Suction groups that have a design saturated suction temperature of 30°F(–1.1°C) or higher, suction groups that comprise the high stage of a two-stage or cascade system or suction groups that primarily serve chillers for secondary cooling fluids.

b. Liquid subcooling shall be provided for all low-temperature compressor systems with a design cooling capacity equal to or greater than 100,000 Btu/h (29.3 (kW) with a design saturated suction temperature of –10°F (–23.3°C) or lower. The subcooled liquid temperature shall be controlled at a maximum temperature setpoint of 50°F (10°C) at the exit of the subcooler using either compressor economizer (interstage) ports or a separate compressor suction group operating at a saturated suction temperature of 18°F (–7.8°C) or higher.

1. Subcooled liquid lines are subject to the insulation requirements of Table 6.8.3B.

c. All compressors that incorporate internal or external crankcase heaters shall provide a means to cycle the heaters off during compressor operation.

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

FOREWORD

In May 2012, the U.S. Department of Energy updated the efficiency values for new motors ranging in size from 1.0 to 500 hp (0.75 to 375 kW) that are made or sold in the United States. As part of this update, the motor definitions were revised, and the motor efficiency tables were updated for large motors (from 250 to 500 hp [187.5 to 375 kW] in size) and fire-pump motors.

This addendum updates the motor definitions in Chapter 3 and the motor efficiency tables in Chapter 10 to ensure that end-users and code officials have the most updated information. In addition, the efficiency requirements for motors that were produced before December 19, 2010, have been removed, since they are no longer allowed to be manufactured in or imported into the Unites States.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum br to Standard 90.1-2010

Modify and add new text to Section 3 as follows (I-P units).

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

[. . .]

~~***general purpose electric motor (subtype I):*** A motor which is designed in standard ratings with either:~~

1. ~~Standard operating characteristics and standard mechanical construction for use under usual service conditions, such as those specified in NEMA Standards Publication MG1–1993, paragraph 14.02, "Usual Service Conditions," and without restriction to a particular application or type of application; or~~
2. ~~Standard operating characteristics or standard mechanical construction for use under unusual service conditions, such as those specified in NEMA Standards Publication MG1–1993, paragraph 14.03, "Unusual Service Conditions," or for a particular type of application, and which can be used in most general purpose applications.~~

[. . .]

~~General purpose electric motors (subtype I) are constructed in NEMA T-frame sizes, or IEC metric equivalent, starting at 143T.~~

~~***general purpose electric motor (subtype II):*** A motor incorporating the design elements of a general purpose electric motor (subtype I) that is configured as one of the following:~~

i. ~~A U-Frame Motor.~~
ii. ~~A Design C Motor.~~
iii. ~~A close-coupled pump motor.~~
iv. ~~A Footless motor.~~
v. ~~A vertical solid shaft normal thrust motor (as tested in a horizontal configuration).~~
vi. ~~An 8-pole motor (900 rpm).~~
vii. ~~A poly-phase motor with voltage of not more than 600 volts (other than 230 or 460 volts).~~

~~Except for U-frame sizes, general purpose electric motor (subtype II) refers to motors constructed in NEMA T-frame sizes, or IEC metric equivalent, starting at 143T.~~

[. . .]

fire-pump electric motor: An electric motor, including any IEC-equivalent, that meets the requirements of Section 9.5 of NFPA 20.

[. . .]

general purpose electric motor (subtype I): A general purpose electric motor that

a. is a single-speed induction motor;
b. is rated for continuous duty (MG1) operation or for duty type SI (IEC);
c. contains a squirrel-cage (MG1) or cage (IEC) rotor;
d. has foot-mounting that may include foot-mounting with flanges or detachable feet;
e. is built in accordance with NEMA T-frame dimensions or their IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;
f. has performance in accordance with NEMA Design A (MG1) or B (MG1) characteristics or equivalent designs, such as IEC Design N (IEC);
g. operates on polyphase alternating current 60 Hz sinusoidal power and
   1. is rated at 230 or 460 V (or both), including motors rated at multiple voltages that include 230 or 460 V (or both) or
   2. can be operated on 230 or 460 V (or both); and
h. includes, but is not limited to, explosion-proof construction.

general purpose electric motor (subtype II): Any general purpose electric motor that incorporates the design elements of a general purpose electric motor (subtype I) and that is configured in one or more of the following ways:

a. Is built in accordance with NEMA U-frame dimensions, as described in NEMA MG-1-1967, or in accordance with the IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents

b. Has performance in accordance with NEMA Design C characteristics, as described in MG1, or an equivalent IEC design(s) such as IEC Design H
c. Is a close-coupled pump motor
d. Is a footless motor
e. Is a vertical solid-shaft normal thrust motor (as tested in a horizontal configuration) built and designed in a manner consistent with MG1
f. Is an 8-pole motor (900 rpm)
g. Is a polyphase motor with voltage rating of not more than 600 V, is not rated at 230 or 460 V (or both), and cannot be operated on 230 or 460 V (or both)

Modify Section 10 as follows (I-P units).

10.4 Mandatory Provisions

10.4.1 Electric Motors. ~~Electric motors manufactured before December 19, 2010 shall comply with the requirements of the Energy Policy Act of 1992 where applicable, as shown in Table 10.8a. Prior to December 19, 2010, motors not included in the scope of the Energy Policy Act of 1992 have no performance requirements in this section, such as but not limited to the following types:~~

~~a. Footless designs~~
~~b. Two-speed versions~~
~~c. 50 Hertz~~
~~d. 200/400 and 575 volt~~
~~e. Design C and D~~
~~f. Close coupled pump motors~~
~~g. TEAO motors~~
~~h. TENV motors~~

Electric motors manufactured alone or as a component of another piece of equipment with a power rating of 1 hp or more, and less than or equal to 200 hp, ~~or after December 19, 2010~~ shall comply with requirements of the Energy Independence and Security Act of 2007, as shown in Table 10.8A~~B~~ for general purpose electric motors (subtype I) and 10.8B~~C~~ for general purpose electric motors (subtype II).

~~Fire pump motors and NEMA Design B,~~ General purpose electric motors (subtype I and II) with a power rating of more that 200 hp, but no more than 500 hp, ~~manufactured on or after December 19, 2010~~, shall have a minimum nominal full-load efficiency that is not less than that shown in Table 10.8C.

Fire-pump electric motors shall have a minimum nominal full-load efficiency that is not less than that shown in Table 10.8F.

Motors that are not included in the scope of the Energy Independence and Security Act of 2007, Section 313, have no performance requirements in this section.

~~TABLE 10.8A Minimum Nominal Efficiency for General Purpose Design A and Design B Motors Rated 600 Volts or Less~~[a]

	~~Minimum Nominal Full-Load Motor Efficiency (%) prior to December 19, 2010~~					
	~~Open Drip-Proof Motors~~			~~Totally Enclosed Fan-Cooled Motors~~		
~~Number of Poles ⇒~~	~~2~~	~~4~~	~~6~~	~~2~~	~~4~~	~~6~~
~~Synchronous Speed (RPM)⇒~~	~~3600~~	~~1800~~	~~1200~~	~~3600~~	~~1800~~	~~1200~~
~~Motor Horsepower~~						
~~1~~	~~NR~~	~~82.5~~	~~80.0~~	~~75.5~~	~~82.5~~	~~80.0~~
~~1.5~~	~~82.5~~	~~84.0~~	~~84.0~~	~~82.5~~	~~84.0~~	~~85.5~~
~~2~~	~~84.0~~	~~84.0~~	~~85.5~~	~~84.0~~	~~84.0~~	~~86.5~~
~~3~~	~~84.0~~	~~86.5~~	~~86.5~~	~~85.5~~	~~87.5~~	~~87.5~~
~~5~~	~~85.5~~	~~87.5~~	~~87.5~~	~~87.5~~	~~87.5~~	~~87.5~~
~~7.5~~	~~87.5~~	~~88.5~~	~~88.5~~	~~88.5~~	~~89.5~~	~~89.5~~
~~10~~	~~88.5~~	~~89.5~~	~~90.2~~	~~89.5~~	~~89.5~~	~~89.5~~
~~15~~	~~89.5~~	~~91.0~~	~~90.2~~	~~90.2~~	~~91.0~~	~~90.2~~
~~20~~	~~90.2~~	~~91.0~~	~~91.0~~	~~90.2~~	~~91.0~~	~~90.2~~
~~25~~	~~91.0~~	~~91.7~~	~~91.7~~	~~91.0~~	~~92.4~~	~~91.7~~
~~30~~	~~91.0~~	~~92.4~~	~~92.4~~	~~91.0~~	~~92.4~~	~~91.7~~
~~40~~	~~91.7~~	~~93.0~~	~~93.0~~	~~91.7~~	~~93.0~~	~~93.0~~
~~50~~	~~92.4~~	~~93.0~~	~~93.0~~	~~92.4~~	~~93.0~~	~~93.0~~
~~60~~	~~93.0~~	~~93.6~~	~~93.6~~	~~93.0~~	~~93.6~~	~~93.6~~
~~75~~	~~93.0~~	~~94.1~~	~~93.6~~	~~93.0~~	~~94.1~~	~~93.6~~
~~100~~	~~93.0~~	~~94.1~~	~~94.1~~	~~93.6~~	~~94.5~~	~~94.1~~
~~125~~	~~93.6~~	~~94.5~~	~~94.1~~	~~94.5~~	~~94.5~~	~~94.1~~
~~150~~	~~93.6~~	~~95.0~~	~~94.5~~	~~94.5~~	~~95.0~~	~~95.0~~
~~200~~	~~94.5~~	~~95.0~~	~~94.5~~	~~95.0~~	~~95.0~~	~~95.0~~

~~a. Nominal efficiencies shall be established in accordance with NEMA Standard MG1 DOE 10 CFR 431. Design A and Design B are National Electric Manufacturers Association (NEMA) design class designations for fixed-frequency small and medium AC squirrel-cage induction motors.~~
~~NR—No requirement~~

TABLE 10.8~~B~~A Minimum Nominal Full-Load Efficiency for ~~60 HZ NEMA~~ General Purpose Electric Motors (Subtype I) ~~Rated 600 Volts or Less (Random Wound)~~[a], Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%) ~~Manufactured on or after December 19, 2010~~						
	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
Number of Poles ⇒	**2**	**4**	**6**	**2**	**4**	**6**
Synchronous Speed (RPM) ⇒	**3600**	**1800**	**1200**	**3600**	**1800**	**1200**
Motor Horsepower						
1	77.0	85.5	82.5	77.0	85.5	82.5
1.5	84.0	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91.0	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93.0	91.7	91.0	92.4	91.7
20	91.0	93.0	92.4	91.0	93.0	91.7
25	91.7	93.6	93.0	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93.0	94.5	94.1	93.0	94.5	94.1
60	93.6	95.0	94.5	93.6	95.0	94.5
75	93.6	95.0	94.5	93.6	95.4	94.5
100	93.6	95.4	95.0	94.1	95.4	95.0
125	94.1	95.4	95.0	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95.0	95.8	95.4	95.4	96.2	95.8
~~250~~	~~95.0~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~300~~	~~95.4~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~350~~	~~95.4~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~400~~	~~95.8~~	~~95.8~~	~~95.8~~	~~95.8~~	~~96.2~~	~~95.8~~
~~450~~	~~95.8~~	~~96.2~~	~~96.2~~	~~95.8~~	~~96.2~~	~~95.8~~
~~500~~	~~95.8~~	~~96.2~~	~~96.2~~	~~95.8~~	~~96.2~~	~~95.8~~

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

TABLE 10.8~~C~~B Minimum Nominal Full-Load Efficiency for General Purpose Electric Motors (Subtype II) ~~and all Design B Motors Greater than 200 hp)~~[a], Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%) ~~Manufactured on or after December 19, 2010~~								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number of Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Horsepower								
1	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.5	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
15	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
50	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
60	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
75	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
100	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
125	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
150	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
200	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
~~250~~	~~94.5~~	~~95.4~~	~~95.4~~	~~94.5~~	~~95.4~~	~~95.0~~	~~95.0~~	~~94.5~~
~~300~~	~~95.0~~	~~95.4~~	~~95.4~~	~~NR~~	~~95.4~~	~~95.4~~	~~95.0~~	~~NR~~
~~350~~	~~95.0~~	~~95.4~~	~~95.4~~	~~NR~~	~~95.4~~	~~95.4~~	~~95.0~~	~~NR~~
~~400~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~
~~450~~	~~95.8~~	~~95.8~~	~~NR~~	~~NR~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~
~~500~~	~~95.8~~	~~95.8~~	~~NR~~	~~NR~~	~~95.4~~	~~95.8~~	~~NR~~	~~NR~~

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

TABLE 10.8C Minimum Nominal Full-Load Efficiency for General Purpose Electric Motors (Subtype I and II), Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%)								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number of Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Horsepower								
250	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5
300	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
350	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
400	95.4	95.4	NR	NR	95.4	95.4	NR	NR
450	95.8	95.8	NR	NR	95.4	95.4	NR	NR
500	95.8	95.8	NR	NR	95.4	95.8	NR	NR

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

TABLE 10.8F Minimum Nominal Full-Load Efficiency for Fire-Pump Electric Motors[a]

Full-Load Efficiency (%)								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number of Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Horsepower								
1	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.5	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
15	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
50	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
60	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
75	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
100	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
125	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
150	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
200	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
250	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5
300	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
350	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
400	95.4	95.4	NR	NR	95.4	95.4	NR	NR
450	95.8	95.8	NR	NR	95.4	95.4	NR	NR
500	95.8	95.8	NR	NR	95.4	95.8	NR	NR

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

Modify and add new text to Section 3 as follows (SI units).

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

[. . .]

~~***general purpose electric motor (subtype I):*** A motor which is designed in standard ratings with either:~~

~~a. Standard operating characteristics and standard mechanical construction for use under usual service conditions, such as those specified in NEMA Standards Publication MG1–1993, paragraph 14.02, "Usual Service Conditions," and without restriction to a particular application or type of application; or~~

~~b. Standard operating characteristics or standard mechanical construction for use under unusual service conditions, such as those specified in NEMA Standards Publication MG1–1993, paragraph 14.03, "Unusual Service Conditions," or for a particular type of application, and which can be used in most general purpose applications.~~

~~General purpose electric motors (subtype I) are constructed in NEMA T-frame sizes, or IEC metric equivalent, starting at 143T.~~

~~***general purpose electric motor (subtype II):*** A motor incorporating the design elements of a general purpose electric motor (subtype I) that is configured as one of the following:~~

~~i. A U-Frame Motor.~~
~~ii. A Design C Motor.~~
~~iii. A close-coupled pump motor.~~
~~iv. A Footless motor.~~
~~v. A vertical solid shaft normal thrust motor (as tested in a horizontal configuration).~~
~~vi. An 8-pole motor (900 rpm).~~
~~vii. A poly-phase motor with voltage of not more than 600 volts (other than 230 or 460 volts).~~

~~Except for U-frame sizes, general purpose electric motor (subtype II) refers to motors constructed in NEMA T-frame sizes, or IEC metric equivalent, starting at 143T.~~

[. . .]

fire-pump electric motor: An electric motor, including any IEC-equivalent, that meets the requirements of Section 9.5 of NFPA 20.

[. . .]

general purpose electric motor (subtype I): A general purpose electric motor that

a. is a single-speed induction motor;
b. is rated for continuous duty (MG1) operation or for duty type SI (IEC);
c. contains a squirrel-cage (MG1) or cage (IEC) rotor;
d. has foot mounting that may include foot mounting with flanges or detachable feet;
e. is built in accordance with NEMA T-frame dimensions or their IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;
f. has performance in accordance with NEMA Design A (MG1) or B (MG1) characteristics or equivalent designs such as IEC Design N (IEC);
g. operates on polyphase alternating current 60 Hz sinusoidal power and
   1. is rated at 230 or 460 V (or both) including motors rated at multiple voltages that include 230 or 460 V (or both) or
   2. can be operated on 230 or 460 V (or both); and
h. includes, but is not limited to, explosion-proof construction.

general purpose electric motor (subtype II): Any general purpose electric motor incorporating the design elements of a general purpose electric motor (subtype I) that is configured in one or more of the following ways:

a. Is built in accordance with NEMA U-frame dimensions, as described in NEMA MG-1-1967, or in accordance with the IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents
b. Has performance in accordance with NEMA Design C characteristics as described in MG1 or an equivalent IEC design(s) such as IEC Design H
c. Is a close-coupled pump motor
d. Is a footless motor
e. Is a vertical solid-shaft normal thrust motor (as tested in a horizontal configuration) built and designed in a manner consistent with MG1
f. Is an 8-pole motor (900 rpm)
g. Is a polyphase motor with voltage rating of not more than 600 V, is not rated at 230 or 460 V (or both), and cannot be operated on 230 or 460 V (or both)

10.4 Mandatory Provisions

10.4.1 Electric Motors. ~~Electric motors manufactured before December 19, 2010 shall comply with the requirements of the Energy Policy Act of 1992 where applicable, as shown in Table 10.8a. Prior to December 19, 2010, motors not included in the scope of the Energy Policy Act of 1992 have no performance requirements in this section, such as but not limited to the following types:~~

~~a. Footless designs~~
~~b. Two-speed versions~~
~~c. 50 Hertz~~
~~d. 200/400 and 575 volt~~
~~e. Design C and D~~
~~f. Close coupled pump motors~~
~~g. TEAO motors~~
~~h. TENV motors~~

Electric motors manufactured alone or as a component of another piece of equipment with a power rating of 0.75 kW or more and less than or equal to 150 kW ~~or after December 19, 2010~~ shall comply with requirements of the Energy Independence and Security Act of 2007, as shown in Table 10.8A~~B~~ for general purpose electric motors (subtype I) and 10.8B~~C~~ for general purpose electric motors (subtype II).

~~Fire pump motors and NEMA Design B,~~ General purpose electric motors (subtype I and II) with a power rating of more that 150 kW, but no more than 373 kW, ~~manufactured on or after December 19, 2010~~, shall have a minimum nominal full-load efficiency that is not less than that shown in Table 10.8C.

Fire-pump electric motors shall have a minimum nominal full-load efficiency that is not less than that shown in Table 10.8F.

Motors that are not included in the scope of the Energy Independence and Security Act of 2007, Section 313, have no performance requirements in this section.

~~TABLE 10.8A Minimum Nominal Efficiency for General Purpose Design A and Design B Motors Rated 600 Volts or Less~~[a]

	~~Minimum Nominal Full-Load Motor Efficiency (%) prior to December 19, 2010~~					
	~~Open Drip-Proof Motors~~			~~Totally Enclosed Fan-Cooled Motors~~		
~~Number of Poles ⇒~~	~~2~~	~~4~~	~~6~~	~~2~~	~~4~~	~~6~~
~~Synchronous Speed (RPM) ⇒~~	~~3600~~	~~1800~~	~~1200~~	~~3600~~	~~1800~~	~~1200~~
~~Motor Size (kW)~~						
~~0.7~~	~~NR~~	~~82.5~~	~~80.0~~	~~75.5~~	~~82.5~~	~~80.0~~
~~1.1~~	~~82.5~~	~~84.0~~	~~84.0~~	~~82.5~~	~~84.0~~	~~85.5~~
~~1.5~~	~~84.0~~	~~84.0~~	~~85.5~~	~~84.0~~	~~84.0~~	~~86.5~~
~~2.2~~	~~84.0~~	~~86.5~~	~~86.5~~	~~85.5~~	~~87.5~~	~~87.5~~
~~3.7~~	~~85.5~~	~~87.5~~	~~87.5~~	~~87.5~~	~~87.5~~	~~87.5~~
~~5.6~~	~~87.5~~	~~88.5~~	~~88.5~~	~~88.5~~	~~89.5~~	~~89.5~~
~~7.5~~	~~88.5~~	~~89.5~~	~~90.2~~	~~89.5~~	~~89.5~~	~~89.5~~
~~11.2~~	~~89.5~~	~~91.0~~	~~90.2~~	~~90.2~~	~~91.0~~	~~90.2~~
~~14.9~~	~~90.2~~	~~91.0~~	~~91.0~~	~~90.2~~	~~91.0~~	~~90.2~~
~~18.7~~	~~91.0~~	~~91.7~~	~~91.7~~	~~91.0~~	~~92.4~~	~~91.7~~
~~22.4~~	~~91.0~~	~~92.4~~	~~92.4~~	~~91.0~~	~~92.4~~	~~91.7~~
~~29.8~~	~~91.7~~	~~93.0~~	~~93.0~~	~~91.7~~	~~93.0~~	~~93.0~~
~~37.3~~	~~92.4~~	~~93.0~~	~~93.0~~	~~92.4~~	~~93.0~~	~~93.0~~
~~44.8~~	~~93.0~~	~~93.6~~	~~93.6~~	~~93.0~~	~~93.6~~	~~93.6~~
~~56.0~~	~~93.0~~	~~94.1~~	~~93.6~~	~~93.0~~	~~94.1~~	~~93.6~~
~~74.6~~	~~93.0~~	~~94.1~~	~~94.1~~	~~93.6~~	~~94.5~~	~~94.1~~
~~93.3~~	~~93.6~~	~~94.5~~	~~94.1~~	~~94.5~~	~~94.5~~	~~94.1~~
~~111.9~~	~~93.6~~	~~95.0~~	~~94.5~~	~~94.5~~	~~95.0~~	~~95.0~~
~~149.2~~	~~94.5~~	~~95.0~~	~~94.5~~	~~95.0~~	~~95.0~~	~~95.0~~

~~a. Nominal efficiencies shall be established in accordance with NEMA Standard MG1 DOE 10 CFR 431. Design A and Design B are National Electric Manufacturers Association (NEMA) design class designations for fixed-frequency small and medium AC squirrel-cage induction motors.~~
~~NR—No requirement~~

TABLE 10.8~~B~~A Minimum Nominal Full-Load Efficiency for ~~60 HZ NEMA~~ General Purpose Electric Motors (Subtype I)~~ Rated 600 Volts or Less (Random Wound)~~[a], Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%) ~~Manufactured on or after December 19, 2010~~						
	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
Number of Poles ⇒	**2**	**4**	**6**	**2**	**4**	**6**
Synchronous Speed (RPM) ⇒	**3600**	**1800**	**1200**	**3600**	**1800**	**1200**
Motor Size (kW)						
0.75	77.0	85.5	82.5	77.0	85.5	82.5
1.1	84.0	86.5	86.5	84.0	86.5	87.5
1.5	85.5	86.5	87.5	85.5	86.5	88.5
2.2	85.5	89.5	88.5	86.5	89.5	89.5
3.7	86.5	89.5	89.5	88.5	89.5	89.5
5.5	88.5	91.0	90.2	89.5	91.7	91.0
7.5	89.5	91.7	91.7	90.2	91.7	91.0
11	90.2	93.0	91.7	91.0	92.4	91.7
15	91.0	93.0	92.4	91.0	93.0	91.7
18.5	91.7	93.6	93.0	91.7	93.6	93.0
22	91.7	94.1	93.6	91.7	93.6	93.0
30	92.4	94.1	94.1	92.4	94.1	94.1
37	93.0	94.5	94.1	93.0	94.5	94.1
45	93.6	95.0	94.5	93.6	95.0	94.5
55	93.6	95.0	94.5	93.6	95.4	94.5
75	93.6	95.4	95.0	94.1	95.4	95.0
90	94.1	95.4	95.0	95.0	95.4	95.0
110	94.1	95.8	95.4	95.0	95.8	95.8
150	95.0	95.8	95.4	95.4	96.2	95.8
~~186~~	~~95.0~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~224~~	~~95.4~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~261~~	~~95.4~~	~~95.8~~	~~95.4~~	~~95.8~~	~~96.2~~	~~95.8~~
~~298~~	~~95.8~~	~~95.8~~	~~95.8~~	~~95.8~~	~~96.2~~	~~95.8~~
~~336~~	~~95.8~~	~~96.2~~	~~96.2~~	~~95.8~~	~~96.2~~	~~95.8~~
~~373~~	~~95.8~~	~~96.2~~	~~96.2~~	~~95.8~~	~~96.2~~	~~95.8~~

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

TABLE 10.8~~C~~B Minimum Nominal Full-Load Efficiency for General Purpose Electric Motors (Subtype II) ~~and all Design B Motors Greater than 200 hp)~~[a], Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%) ~~Manufactured on or after December 19, 2010~~								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number for Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Size (kW)								
0.75	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.1	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
1.5	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
2.2	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
3.7	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
5.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
7.5	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
11	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
15	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
18.5	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
22	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
30	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
37	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
45	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
55	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
75	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
90	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
110	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
150	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
~~186~~	~~94.5~~	~~95.4~~	~~95.4~~	~~94.5~~	~~95.4~~	~~95.0~~	~~95.0~~	~~94.5~~
~~224~~	~~95.0~~	~~95.4~~	~~95.4~~	~~NR~~	~~95.4~~	~~95.4~~	~~95.0~~	~~NR~~
~~261~~	~~95.0~~	~~95.4~~	~~95.4~~	~~NR~~	~~95.4~~	~~95.4~~	~~95.0~~	~~NR~~
~~298~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~
~~336~~	~~95.8~~	~~95.8~~	~~NR~~	~~NR~~	~~95.4~~	~~95.4~~	~~NR~~	~~NR~~
~~373~~	~~95.8~~	~~95.8~~	~~NR~~	~~NR~~	~~95.4~~	~~95.8~~	~~NR~~	~~NR~~

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

TABLE 10.8C Minimum Nominal Full-Load Efficiency for General Purpose Electric Motors (Subtype I and II), Except Fire-Pump Electric Motors[a]

Full-Load Efficiency (%)								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number of Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Size (kW)								
186	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5
224	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
261	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
298	95.4	95.4	NR	NR	95.4	95.4	NR	NR
336	95.8	95.8	NR	NR	95.4	95.4	NR	NR
373	95.8	95.8	NR	NR	95.4	95.8	NR	NR

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

TABLE 10.8F Minimum Nominal Full-Load Efficiency of Fire-Pump Electric Motors[a]

Full-Load Efficiency (%)								
	Open Drip-Proof Motors				Totally Enclosed Fan-Cooled Motors			
Number of Poles ⇒	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ⇒	3600	1800	1200	900	3600	1800	1200	900
Motor Size (kW)								
0.75	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0
1.1	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
1.5	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
2.2	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
3.7	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
5.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
7.5	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
11	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
15	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
18.5	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
22	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
30	91.7	93.0	93.0	91.0	91.7	93.0	93.0	91.0
37	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
45	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
55	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
75	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
90	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
110	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
150	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
186	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5
224	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
261	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
298	95.4	95.4	NR	NR	95.4	95.4	NR	NR
336	95.8	95.8	NR	NR	95.4	95.4	NR	NR

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.
NR—No requirement

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

FOREWORD

This addendum reduces occupancy threshold for demand controlled ventilation from >40 people per 1000 ft^2 to ≥25 people per 1000 ft^2 with exceptions for certain occupancies. This change will expand the occupancies where demand controlled ventilation is required. Occupancies that would be included that are not included now (based on ASHRAE Standard 62.1 default densities) would be classrooms, music/dance studios, conference lobbies, office reception areas, museums, mall commons, gyms and health clubs, daycare facilities, computer labs, and break rooms. Exempt occupancies would be correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.

The expansion to more spaces is justified based on reduction in costs for demand controlled ventilation controls and increases in ventilation energy costs. These lower density thresholds have been adopted in many state energy codes, including those of Washington, Oregon, and California. There is also a LEED credit available for IAQ monitoring met by the most typical demand controlled ventilation method.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifi-

Addendum bs to Standard 90.1-2010

Revise the standard as follows (I-P and SI Units)

6.4.3.9 Ventilation Controls for High-Occupancy Areas. Demand control ventilation (DCV) is required for spaces larger than 500 ft^2 and with a design occupancy for ventilation of ≥25 ~~40~~ people per 1000 ft^2 of floor area and served by systems with one or more of the following:

a. an air-side economizer,
b. automatic modulating control of ~~the~~ outdoor air damper, or
c. a design outdoor airflow greater than 3000 cfm.

Exceptions:

a. Systems with the exhaust air energy recovery complying with Section 6.5.6.1.
b. Multiple-zone systems without DDC of individual zones communicating with a central control panel.
c. Systems with a design outdoor airflow less than 750~~1200~~ cfm (375~~600~~ L/s).
d. Spaces where >75% of the ~~supply~~ space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other space(s).
e. Spaces with one of the following occupancy categories as defined in ASHRAE Standard 62.1: correctional cells; daycare sickrooms; science labs; barbers; beauty and nail salons; and bowling alley seating.

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

FOREWORD

This addendum revises the requirements for the use of exhaust air energy recovery as defined in Table 6.5.6.1.

The current table requires energy recovery as a function of the percent outdoor air and design supply fan airflow, and defines requirements for energy recover for outdoor air ventilation rates above 30%. Many buildings, including offices, motels, hotels, grocery, and warehouses, operate with ventilation rates below 30% and represent a significant part of the market. Additional energy savings can be had for these buildings, where economically justified, by extending the table to address outdoor air ventilation rates below 30%. Using the tool developed for ASHRAE/IES Standard 90.1-2010 table development, a full 8760-hour simulation was run for building office, school, and retail applications down to 10% outdoor air. Then the least restrictive cfm values were selected for the table based on the 2010 scalar values using a design life of 15 years. The results were additional requirements for energy recovery with regard to larger systems in climate zones 1A, 2A, 3A, 4A, 5A, 6A, 7, and 8, which represent 30.8% of the market.

In addition to changes to extend the table to encompass outdoor air ventilation rates below 30%, this addendum also modifies the requirement for climate zones 3B, 3C, 4B, 4C, and 5B, as they are not economical justifiable and have scalar values from 20.3 years to infinity. The value for energy recover use of 5000 cfm (2360 L/s) was carried over to the 2010 edition of Standard 90.1 from 2007 edition. SSPC 90.1 received feedback that other studies confirm these values are not cost effective and should be corrected.

This addendum revises the requirements for the use of exhaust air energy recovery as defined in Table 6.5.6.1

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bt to Standard 90.1-2010

Revise the standard as follows for (I-P and SI units, respectively.

TABLE 6.5.6.1 Energy Recovery Requirement (I-P)

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design Supply Fan Airflow Rate (cfm)							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	~~≥5000~~NR	~~≥5000~~NR
1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28000	≥26500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥26000	≥16000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0
7,8	≥4500	≥4000	≥2500	≥1000	≥0	≥0	≥0	≥0

NR—Not required

TABLE 6.5.6.1 Energy Recovery Requirement (SI)

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design Supply Fan Airflow Rate (L/s)							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	~~≥2360~~NR	~~≥2360~~NR
1B, 2B,5C	NR	NR	NR	NR	≥12271	≥5663	≥2360	≥1888
6B	≥13215	≥12507	≥5191	≥2596	≥2124	≥1652	≥1180	≥708
1A, 2A, 3A, 4A, 5A, 6A	≥12271	≥7551	≥2596	≥2124	≥1652	≥944	≥472	≥0
7,8	≥2124	≥1888	≥1180	≥472	≥0	≥0	≥0	≥0

NR—Not required

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

FOREWORD

This revision of the toplighting requirements reduces the space area threshold, adds single-story buildings, and expands the list of spaces where daylight would not adversely affect operation of the space (such as a movie theater seating area where daylight is not appropriate). The new requirements were part of the 50% concept analysis that PNNL completed in Fall 2011.

The existing requirement states that in enclosed spaces larger than 5000 ft^2 and with ceiling heights greater than 15 ft (4.57 m), a minimum skylight fenestration area must be provided. This addendum reduces the enclosed space area threshold from 5000 to 2500 ft^2 (465 to 232 m^2), which brings in more high-ceiling spaces and spaces in single-story buildings that were previously not required to install skylights.

PNNL analyzed the energy savings from this measure using the Standalone Retail prototype model. The energy consumption was reduced on an average across climate zones 1 through 6 by 1.1%, or 6660 kWh, annually. The cost effectiveness of the reduced threshold was also analyzed. Costs for skylights were gathered from online sources, installation and labor costs were obtained from RS Means, and photocontrol costs are from HMG. Using a cost-weighted measure life approach, it was found that reducing the space area threshold for skylights is cost effective.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bv to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

5.5.4.2.3 Minimum Skylight Fenestration Area. In any enclosed space in a building ~~that is four stories or less and~~ that is

a. ~~5,000ft^2~~ ≥2500 ft^2 (~~465 m^2~~232 m^2),

b. directly under a roof with a ceiling height greater than 15 ft and,

c. one of the following space types: office, lobby, atrium, concourse, corridor, storage (including nonrefrigerated warehouse), gymnasium, fitness/exercise area, playing area, gymnasium seating area, convention exhibit/event space, courtroom, automotive service, fire station engine room, manufacturing corridor/transition and bay areas, retail, library reading and stack areas, distribution/sorting area, transportation baggage and seating areas, or workshop,

the total daylight area under skylights shall be a minimum of half the floor area and either

d. provide a minimum skylight area to daylight area under skylights of 3% with a skylight VT of at least 0.40 or

e. provide a minimum skylight effective aperture of at least 1%.

These skylights shall have a glazing material or diffuser with a measured haze value greater than 90% when tested in accordance with ASTM D1003. General lighting in the daylight area shall be controlled as described in Section 9.4.1.5.

Exceptions to Section 5.5.4.2.3:

a. Enclosed spaces in climate zones 6 through 8.

~~b. Enclosed spaces with designed general lighting power densities less than 0.5 W/ft^2.~~

~~a.~~b. Enclosed spaces where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed space for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.

~~b.~~c. Enclosed spaces where the daylight area under rooftop monitors is greater than 50% of the enclosed space floor area.

~~c.~~d. Enclosed spaces where it is documented that 90% of the skylight area is shaded on June 21 in the Northern Hemisphere (December 21 in the Southern Hemisphere) at noon by permanent architectural features of the building.

~~d. Primary sidelighted areas with a sidelighting effective apertures greater than 0.15 where the lighting is controlled according to sidelighting requirements described in Section 9.4.1.4.~~

~~e. Secondary sidelighted areas with a sidelighting effective aperture greater than 0.30 where the lighting is controlled according to sidelighting requirements described in Section 9.4.1.4.~~

e. Enclosed spaces where the total area minus the primary and secondary sidelighted area(s) is less than 2500 ft^2 (232 m^2) and where the lighting is controlled according to sidelighting requirements described in Section 9.4.1.4.

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FOREWORD

This revision to the building/fenestration orientation requirements provides more specific requirements for east and west facing fenestration while also providing more flexibility for complying. Analyses indicate that east and west facing fenestration increases building energy consumption compared to north and south facing glazing in all climates. The criteria can be met by limiting fenestration area, changing the fenestration SHGC, or orienting the building so that the long axis is in the east-west direction. A number of exceptions are provided. New exceptions include one for buildings with less than 20% fenestration on the east and west facades and one for buildings in Climate Zone 8. The definitions for the areas east and west oriented fenestration have also been further refined.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bw to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

5.5.4.5 Fenestration Orientation. The vertical fenestration ~~area~~ shall comply with either (a) or (b) ~~meet the following requirement~~:

$$\cancel{A_S \geq A_W \text{ and } A_S \geq A_E}$$

a. $A_W \leq (A_T)/4$ and $A_E \leq (A_T)/4$

b. $A_W \times SHGC_W \leq (A_T \times SHGC_C)/4$ and $A_E \times SHGC_E \leq (A_T \times SHGC_C)/4$

where

~~A_s = south-oriented vertical fenestration area (oriented ≤45 degrees of true south)~~

~~A_n = north-oriented vertical fenestration area (oriented ≤45 degrees of true north)~~

A_w = west-oriented vertical fenestration area (oriented within <~~30~~45 degrees of true west to the south and within 22.5 degrees of true west to the north in the northern hemisphere; oriented within 45 degrees of true west to the north and within 22.5 degrees of true west to the south in the southern hemisphere)

A_e = east-oriented vertical fenestration area (oriented within <~~30~~45 degrees of true east to the south and within 22.5 degrees of true east to the north in the northern hemisphere; oriented within 45 degrees of true east to the north and within 22.5 degrees of true east to the south in the southern hemisphere)

A_T = total vertical fenestration area

$SHGC_C$ = SHGC criteria in Tables 5.5A through 5.5H for each climate zone

$SHGC_E$ = SHGC for east-oriented fenestration that complies with Section 5.5.4.4.1

$SHGC_W$ = SHGC for west-oriented fenestration that complies with Section 5.5.4.4.1

~~In the southern hemisphere, replace *As* with *An* in the formulae above.~~

Exceptions:

a. Vertical fenestration that complies with the exception to Section 5.5.4.4.1c

b. Buildings that have an existing building or existing permanent infrastructure within 20 ft (6 m) to the south (north in the southern hemisphere) which is at least half as tall as the proposed building.

c. Buildings with shade on 75% of the west and east oriented vertical fenestration areas from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere)

d. Alterations and additions with no increase in vertical fenestration area

e. Buildings where the west-oriented and east-oriented vertical fenestration area (as defined in Section 5.5.4.5) does not exceed 20% of the gross wall area for each of those façades, and SHGC on those facades is no greater than 90% of the criteria in Tables 5.5A through 5.5H

f. Buildings in Climate Zone 8

Revise Table 11.3.1 as follows (I-P and SI units).

TABLE 11.3.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

No.	Proposed Building Design (Column A) Design Energy Cost (DEC)	Budget Building Design (Column B) Energy Cost Budget (ECB)
[. . .]		
5. Building Envelope		
	All components of the building envelope in the proposed building design shall be modeled as shown on architectural drawings or as installed for existing building envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. a. Any envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of an envelope assembly must be added to the area of the adjacent assembly of that same type. b. Exterior surfaces whose azimuth orientation and tilt differ by no more than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. c. The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.1(a). Where aged test data is unavailable, the roof surface shall be modeled with a solar reflectance of 0.30 and a thermal emittance of 0.90. d. Manually operated fenestration shading devices such as blinds or shades shall not be modeled. Permanent shading devices such as fins, overhangs, and lightshelves shall be modeled.	The budget building design shall have identical conditioned floor area and identical exterior dimensions and orientations as the proposed building design, except as follows: a. Opaque assemblies such as roof, floors, doors, and walls shall be modeled as having the same heat capacity as the proposed building design but with the minimum U-factor required in Section 5.5 for new buildings or additions and Section 5.1.3 for alterations. b. *Roof Solar Reflectance and Thermal Emittance.* The exterior roof surfaces shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.1.1(a). All other roofs, including roofs exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as the proposed design. c. *Fenestration*. No shading projections are to be modeled; fenestration shall be assumed to be flush with the exterior wall or roof. If the fenestration area for new buildings or additions exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. If the vertical fenestration area facing west or east of the proposed building exceeds the area limit set in Section 5.5.4.5 ~~the area shall be reduced proportionally until the area is the same as the area limit set in Section 5.5.4.5. The area limit is the fenestration area facing south in the northern hemisphere or the fenestration area facing north in the southern hemisphere as defined in Section 5.5.4.5.~~ then the energy-cost budget shall be generated by simulating the budget building design with its actual orientation and again after rotating the entire budget building design 90, 180, and 270 degrees and then averaging the results. Fenestration U-factor shall be equal to the criteria from Tables 5.5-1 through 5.5-8 for the appropriate climate, and the SHGC shall be equal to the criteria from Tables 5.5-1 through 5.5-8 for the appropriate climate. For portions of those tables where there are no SHGC requirements, the SHGC shall be equal to that determined in accordance with Section C3.5. The VT shall be equal to that determined in accordance with Section C3.5. The fenestration model for envelope alterations shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3. **Exception:** When trade-offs are made between an addition and an existing building as described in the Exception to Section 4.2.1.2, the envelope assumptions for the existing building in the budget building design shall reflect existing conditions prior to any revisions that are part of this permit.

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FOREWORD

The purpose of this addendum is to remove confusion about how the exceptions to the occupancy sensor requirement work and to eliminate one of those exceptions since technology changes make it no longer needed.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum bx to Standard 90.1-2010

Modify Section 9.4.1.2 as follows for I-P and SI units.

Exceptions to Section 9.4.1.2b: ~~These spaces are not required to be connected to other *automatic* lighting shutoff controls:~~

~~a. Spaces with *multi-scene control* systems,~~

~~b~~a. shop and laboratory classrooms,

~~c~~b. spaces where an *automatic shutoff* would endanger the safety or security of the room or building occupant(s), and

~~d~~c. Spaces where lighting is required for 24-hour operation.

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

FOREWORD

The goal of this addendum is three-fold. First, it increases the stringency of the standard by (a) requiring the use of certain lighting controls in more space types and (b) shortening times until the lights are automatically reduced or shut off. Second, the design community has asked for a tabular structure for specifying the controls requirements. It is felt that by putting these requirements into a tabular format the provisions will be clearer and therefore more likely to be complied with and easier to enforce. Third, modifications have been made to correct the errors for the wattage threshold for sidelighting and toplighting for daylight responsive controls.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum by to Standard 90.1-2010

Modify Section 9.4.1 as follows (I-P and SI units).

9.4.1 Lighting Control

[. . .]

~~Any automatic control device required in sections 9.4.1.1, 9.4.1.2, and 9.4.1.46 shall either be manual on or shall be controlled to automatically turn the lighting on to not more than 50% power, except in the following spaces where full automatic-on is allowed;~~

~~a. public corridors and stairwells,~~

~~b. restrooms,~~

~~c. primary building entrance areas and lobbies, and~~

~~d. areas where manual-on operation would endanger the safety or security of the room or building occupant(s).~~

~~**9.4.1.1 Automatic Lighting Shutoff.** Interior lighting in buildings shall be controlled with an automatic control device to shut off building lighting in all spaces. This automatic control device shall function on either~~

~~a. a scheduled basis using a time-of-day operated control device that turns lighting off at specific programmed times—an independent program schedule shall be provided for areas of no more than 25,000 ft2 but not more than one floor—or~~

~~b. an occupant sensor that shall turn lighting off within 30 minutes of an occupant leaving a space, or~~

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

~~**Exceptions:** The following shall not require an automatic control device:~~

~~a. Lighting required for 24-hour operation.~~

~~b. Lighting in spaces where patient care is rendered.~~

~~c. Lighting in spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s).~~

~~**9.4.1.2 Space Control.** Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space. Each manual device shall be readily accessible and located so the occupants can see the controlled lighting. All controlled lighting shall meet the following requirements:~~

~~a. The controlled lighting shall have at least one control step between 30% and 70% (inclusive) of full lighting power in addition to all off.~~

~~**Exceptions:**~~

~~a. Lights in corridors, electrical/mechanical rooms, public lobbies, restrooms, stairways, and storage rooms~~

~~b. Spaces with only one luminaire with rated input power less than 100 W.~~

~~c. Spaces types with lighting power allowance of less than 0.6 W/ft2 (see Table 9.6.1).~~

~~b. An occupant sensor or a timer switch shall be installed that automatically turns lighting off within 30 minutes of all occupants leaving a space in:~~

~~1. classrooms and lecture halls,~~

~~2. conference, meeting, and training rooms,~~

~~3. employee lunch and break rooms,~~

~~4. storage and supply rooms between 50 ft2 and 1000 ft2,~~

~~5. rooms used for document copying and printing,~~

~~6. office spaces up to 250 ft2,~~

~~7. restrooms, and~~

~~8. dressing, locker, and fitting rooms.~~

~~**Exceptions:** These spaces are not required to be connected to other automatic lighting shutoff controls:~~

~~a. Spaces with multi-scene control systems,~~

~~b. shop and laboratory classrooms,~~

~~c. spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s), and~~

~~d. lighting required for 24-hour operation.~~

~~c. For spaces not included in 9.4.1.2b, each control device shall be activated either manually by an occupant or automatically by sensing an occupant. Each control device shall control a maximum of 2500 ft2 area for a space 10,000 ft2 or less and a maximum of 10,000 ft2 area for a space greater than 10,000 ft2. The occupant shall be able to override any time-of-day scheduled shutoff control for no more than two hours.~~

~~**Exception:** Remote location shall be permitted for reasons of safety or security when the remote control device has an indicator pilot light as part of or next to the control device and the light is clearly labeled to identify the controlled lighting.~~

~~**9.4.1.3 Parking Garage Lighting Control.** Lighting for parking garages shall comply with the following requirements:~~

- ~~a. Comply with Section 9.4.1.1.~~
- ~~b. Lighting shall be controlled by one or more devices that automatically reduce lighting power of each luminaire by a minimum of 30% when there is no activity detected within a lighting zone for no more than 30 minutes. Lighting zones for this requirement shall be no larger than 3,600 ft2,~~
- ~~c. Daylight transition zone lighting, as described in Section 9.2.2.3 exception r, shall be separately controlled by a device that automatically turns lighting on during daylight hours and off at sunset.~~
- ~~d. For luminaires within 20 ft of any perimeter wall structure that has a net opening to wall ratio of at least 40% and no exterior obstructions within 20 ft, the power shall be automatically reduced in response to daylight.~~

~~**Exceptions:**~~

- ~~a. Daylight transitions zones and ramps without parking are exempt from sections b and d above.~~
- ~~b. Applications using HID of 150 watts or less or Induction lamps are exempt from section b above.~~

~~**9.4.1.4 Automatic Daylighting Controls for Primary Sidelighted Areas.** When the combined primary sidelighted area in an enclosed space equals or exceeds 250 ft2, the lamps for general lighting in the primary sidelighted area shall be separately controlled by at least one multilevel photocontrol (including continuous dimming devices) having the following characteristics:~~

- ~~a. the light sensor for the photocontrol shall be remote from where calibration adjustments are made;~~
- ~~b. the calibration adjustments shall be readily accessible; and~~
- ~~c. the multilevel photocontrol shall reduce electric lighting in response to available daylight with at least one control step that is between 50% and 70% of design lighting power and another control step that is no greater than 35% (including off) of design power.~~

~~**Exceptions:**~~

- ~~a. Primary sidelighted areas where the top of the existing adjacent structures are twice as high above the windows as their distance away from the windows~~
- ~~b. Primary sidelighted areas where the sidelighting effective aperture is less than 0.1 (10%)~~
- ~~c. Retail spaces~~

~~**9.4.1.5 Automatic Daylighting Controls for Toplighting.** When the total daylight area under skylights plus the total daylight area under clerestories rooftop monitors in an enclosed space exceeds 900 ft2, the lamps for general lighting in the daylight area shall be separately controlled by at least one multilevel photocontrol (including continuous dimming devices) having the following characteristics:~~

- ~~a. the light sensor for the photocontrol shall be remote from where calibration adjustments are made,~~
- ~~b. the calibration adjustments shall be readily accessible, and~~
- ~~c. the multilevel photocontrol shall reduce electric lighting in response to available daylight with at least one control step that is between 50% and 70% of design lighting power and another control step that is no greater than 35% of design power.~~

~~**Exceptions:**~~

- ~~a. Daylighted areas under skylights where it is documented that existing adjacent structures or natural objects block direct beam sunlight for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.~~
- ~~b. Daylighted areas where the skylight effective aperture (EA) is less than 0.006 (0.6%).~~
- ~~c. Buildings in climate zone 8 with daylight areas totaling less than 1,500 ft2 in an enclosed space.~~

~~**9.4.1.6 Additional Control.** Additional controls shall meet the following requirements:~~

- ~~a. Display/Accent Lighting—display or accent lighting shall have a separate control device.~~
- ~~b. Case Lighting—lighting in cases used for display purposes shall have a separate control device.~~
- ~~c. Guest Room Lighting—Guestrooms in hotels, motels, boarding houses or similar buildings shall have one or more control device(s) at the entry door that collectively control all permanently installed luminaires and switched receptacles, except those in the bathroom(s). Suites shall have control(s) meeting these requirements at the entry to each room or at the primary entry to the suite. Bathrooms shall have a control device installed to automatically turn off the bathroom lighting, except for night lighting not exceeding 5 watts, within 60 minutes of the occupant leaving the space."~~
- ~~d. Task Lighting—supplemental task lighting, including permanently installed undershelf or undercabinet lighting, shall have a control device integral to the luminaires or be controlled by a wall-mounted control device provided the control device is readily accessible and located so that the occupant can see the controlled lighting.~~
- ~~e. Nonvisual Lighting—lighting for nonvisual applications, such as plant growth and food warming, shall have a separate control device.~~
- ~~f. Demonstration Lighting—lighting equipment that is for sale or for demonstrations in lighting education shall have a separate control device.~~
- ~~g. Stairwell Lighting—Lighting in stairwells shall have one or more control devices to automatically reduce lighting power in any one controlled zone by at least 50% within 30 minutes of all occupants leaving that controlled zone.~~

9.4.1 Lighting Control. Building lighting controls shall be installed to meet the provisions of Sections 9.4.1.1, 9.4.1.2, 9.4.1.3, and 9.4.1.4. ~~, 9.4.1.5, 9.4.1.6, and 9.4.1.7~~.

9.4.1.1 Interior Lighting Controls. For each space in the building, all of the lighting control functions indicated in Table 9.6.1, for the appropriate space type in column A, and as described below, shall be implemented. All control functions labeled with an "REQ" are mandatory and shall be implemented. If a space type has control functions labeled "ADD1" then at least one of those functions shall be implemented. If a space type has control functions labeled "ADD2" then at least one of those functions shall be implemented. For space types not listed, select a reasonably equivalent type.

If using the space-by-space method for LPD requirements, the space type used for determining control requirements shall be the same space type used to determine the LPD.

a. *Local control:* There shall be one or more manual lighting controls in the space that controls all of the lighting in the space. Each control device shall control an area (1) no larger than 2500 ft^2 (232m^2) if the space is ≤10,000 ft^2 (929 m^2) and (2) no larger than 10,000 ft^2 (929 m^2) otherwise. The device installed to comply with this provision shall be readily accessible and located so that the occupants can see the controlled lighting when using the control device.

Exception: Remote location of this local control device or devices shall be permitted for reasons of safety or security when each remote control device has an indicator pilot light as part of or next to the control device and the light is clearly labeled to identify the controlled lighting.

b. *Restricted to manual ON:* None of the lighting shall be automatically turned on.

Exception: Manual ON is not required where 'manual on' operation of the general lighting would endanger the safety or security of the room or building occupants.

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

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

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

In any space where the combined input power of all general lighting completely or partially within the primary and secondary sidelighted areas is 300 W or greater, the general lighting in the primary sidelighted areas and secondary sidelighted areas shall be controlled by photocontrols.

The control system shall have the following characteristics:

1. The calibration adjustments shall be readily accessible.
2. At minimum, general lighting in the secondary sidelighted area shall be controlled independently of the general lighting in the primary sidelighted area.
3. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or with at least one control point between 50% and 70% of design lighting power, a second control point between 20% and 40% of design lighting power or the lowest dimming level the technology allows, and a third control point that turns off all the controlled lighting.

Exceptions: The following areas are exempted from Section 9.4.1.1(e):

a. Primary sidelighted areas where the top of any existing adjacent structure is twice as high above the windows as its distance away from the windows
b. Sidelighted areas where the total glazing area is less than 20 ft^2 (1.9 m^2)
c. Retail spaces

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

1. The calibration adjustments shall be readily accessible.
2. The photocontrol shall reduce electric lighting in response to available daylight using continuous dimming or with at least one control point that is between 50% and 70% of design lighting power, a second control point between 20% and 40% of design lighting power or the lowest dimming level the technology allows, and a third control point that turns off all the controlled lighting.
3. General lighting in overlapping toplighted and sidelighted daylight areas shall be controlled together with general lighting in the daylight area under skylights or daylight areas under roof monitors.

Exceptions: The following areas are exempted from Section 9.4.1.1(f):

a. Daylight areas under skylights where it is documented that existing adjacent structures or natural objects block direct sunlight for more than 1500 daytime hours per year between 8 a.m. and 4 p.m.
b. Daylight areas where the skylight visual transmittance (VT) is less than 0.4
c. In each space within buildings in Climate Zone 8 where the input power of the general lighting within daylight areas is less than 200 W

g. *Automatic partial OFF (full OFF complies):* The general lighting power in the space shall be automatically reduced by at least 50% within 20 minutes of all occupants leaving the space.

Exceptions: This requirement does not have to be complied with in spaces that meet all three of the following requirements:

a. The space has an LPD of no more than 0.80 W/ft^2 (8.6 W/m^2).
b. The space is lighted by HID.
c. The general lighting power in the space is automatically reduced by at least 30% within 20 minutes of all occupants leaving the space.

h. *Automatic full OFF:* All lighting shall be automatically shut off within 20 minutes of all occupants leaving the space. A control device meeting this requirement shall control no more than 5000 ft^2 (465 m^2).

Exceptions: The following lighting is not required to be automatically shut off:

a. General lighting and task lighting in shop and laboratory classrooms
b. General lighting and task lighting in spaces where automatic shutoff would endanger the safety or security of room or building occupants
c. Lighting required for 24/7 operation

i. *Scheduled shutoff:* All lighting in the space not exempted by Section 9.1.1, Exception (a), shall be automatically shut off during periods when the space is scheduled to be unoccupied using either (1) a time-of-day operated control device that automatically turns the lighting off at specific programmed times or (2) a signal from another automatic control device or alarm/security system. The control device or system shall provide independent control sequences that (1) control the lighting for an area of no more than 25000 ft^2 (2323 m^2), (2) include no more than one floor, and (3) shall be programmed to account for weekends and holidays. Any manual control installed to provide override of the scheduled shutoff control shall not turn the lighting on for more than two hours per activation during scheduled off periods and shall not control more than 5000 ft^2 (465 m^2).

Exceptions: The following lighting is not required to be on scheduled shutoff:

a. Lighting in spaces where lighting is required for 24/7 continuous operation
b. Lighting in spaces where patient care is rendered
c. Lighting in spaces where automatic shutoff would endanger the safety or security of the room or building occupants

9.4.1.2 Parking Garage Lighting Control. Lighting for parking garages shall comply with the following requirements:

a. Parking garage lighting shall have automatic lighting shutoff per Section 9.4.1.1(a)
b. Lighting power of each luminaire shall be automatically reduced by a minimum of 30% when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be no larger than 3600 ft^2 (334 m^2). The following areas are exempt from Section 9.4.1.2(b):
   1. Daylight transitions zones and ramps without parking
c. Lighting for covered vehicle entrances and exits from buildings and parking structures shall be separately controlled by a device that automatically reduces the lighting by at least 50% from sunset to sunrise.
d. The power to luminaires within 20 ft (1.9 m^2) of any perimeter wall structure that has a net opening-to-wall ratio of at least 40% and no exterior obstructions within 20 ft (1.9 m^2), shall be automatically reduced in response to daylight. Lighting in the following areas is exempt from Section 9.4.1.2(d):
   1. Daylight transitions zones and ramps without parking

9.4.1.3 Special Applications

a. The following lighting shall be separately controlled from the general lighting in all spaces:
   1. Display or accent lighting
   2. Lighting in display cases
   3. Nonvisual lighting, such as for plant growth or food warming
   4. Lighting equipment that is for sale or used for demonstrations in lighting education
b. Guestrooms
   1. All lighting and all switched receptacles in guestrooms and suites in hotels, motels, boarding houses, or similar buildings shall be automatically controlled such that the power to the lighting and switched receptacles will be turned off within 20 minutes after all occupants leave the room.

Exception: Bathroom lighting and lighting and switched receptacles controlled by captive key systems are exempt from Section 9.4.1.3(b)(1).

   2. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting within 30 minutes of the occupant leaving the space.

Exception: Night lighting of up to 5 W per bathroom is exempt from Section 9.4.1.3(b)(2)

c. All supplemental task lighting, including permanently installed undershelf or undercabinet lighting, shall be controlled from either (1) a control device integral to the luminaires or (2) by a wall-mounted control device that is readily accessible and located so that the occupant can see the controlled lighting.

~~9.4.1.7~~9.4.1.4 Exterior Lighting Control

[. . .]

Replace Table 9.6.1 with the following (I-P and SI units).

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

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Atrium											
… that is <20 ft (6.1 m) in height	0.03/ft (1.1/m) total height	NA	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
… that is ≥20 ft (6.1 m) and ≤40 ft (12.2 m) in height	0.03/ft (1.1/m) total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… that is >40 ft (12.2 m) in height	0.40 + 0.02/ft (4.3 + 0.7/m) total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Audience Seating Area											
... in an auditorium	0.63 (6.8)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
... in a convention center	0.82 (8.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a gymnasium	0.65 (7.1)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
... in a motion picture theater	1.14 (12.3)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
... in a penitentiary	0.28 (3.1)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
... in a performing arts theater	2.43 (26.2)	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
... in a religious building	1.53 (16.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
... in a sports arena	0.43 (4.7)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
… all other audience seating areas	0.43(4.7)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Banking Activity Area	1.01 (11.9)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Breakroom (See Lounge/Breakroom)											

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e[6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f[6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Classroom/Lecture Hall/ Training Room											
… in a penitentiary	1.34 (14.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
… all other classrooms/lecture halls/training rooms	1.24 (13.4)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
Conference/Meeting/ Multipurpose Room	1.23 (13.3)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
Confinement Cells	0.81 (8.8)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Copy/Print Room	0.72 (7.8)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
Corridor[2]											
… in an assisted living facility (and used primarily by residents)[3]	0.92 (9.9)	width <8 ft(2.4 m)	REQ				REQ	REQ	REQ	ADD2	ADD2
… in a hospital	0.99 (10.7)	width <8 ft(2.4 m)	REQ				REQ	REQ	ADD2	ADD2	ADD2
… in a manufacturing facility	0.41 (4.4)	width <8 ft(2.4 m)	REQ				REQ	REQ		ADD2	ADD2
… all other corridors	0.66 (7.1)	width <8 ft(2.4 m)	REQ				REQ	REQ	REQ	ADD2	ADD2
Courtroom	1.72 (18.6)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Computer Room	1.71 (18.4)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Dining Area											
… in a penitentiary	0.96 (10.4)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in an assisted living facility (and used primarily by residents)[3]	1.90 (20.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in bar/lounge or leisure dining	1.07 (11.6)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in cafeteria or fast food dining	0.65 (7.0)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a]) a	Restricted to Manual ON (See Section 9.4.1.1[b]) b	Restricted to Partial Automatic ON (See Section 9.4.1.1[c]) c	Bi-level Lighting Control (See Section 9.4.1.1[d]) d	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6]) e	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6]) f	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies]) g	Automatic Full OFF (See Section 9.4.1.1[h]) h	Scheduled Shutoff (See Section 9.4.1.1[i]) i
… in family dining	0.89 (9.6)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… all other dining areas	0.65 (7.0)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Electrical/Mechanical Room	0.42 (4.6)	6	REQ				REQ	REQ			
Emergency Vehicle Garage	0.56 (6.1)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Food Preparation Area	1.21 (13.1)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Guest Room	0.47 (5.1)	6					See Section 9.4.1.3b.				
Laboratory											
… in or as a classroom	1.43 (15.5)	6	REQ	ADD1	ADD1	REQ	REQ	REQ	REQ	ADD2	ADD2
… all other laboratories	1.81 (19.5)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Laundry/Washing Area	0.60 (6.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Loading Dock, Interior	0.47 (5.1)	6	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Lobby											
… in an assisted living facility (and used primarily by residents)[3]	1.80 (19.4)	4	REQ				REQ	REQ	REQ	ADD2	ADD2
… for an elevator	0.64 (7.0)	6	REQ				REQ	REQ		ADD2	ADD2
… in a hotel	1.06 (11.5)	4	REQ				REQ	REQ		ADD2	ADD2
… in a motion picture theater	0.59 (6.4)	4	REQ				REQ	REQ		ADD2	ADD2
… in a performing arts theater	2.00 (21.6)	6	REQ				REQ	REQ	REQ	ADD2	ADD2
… all other lobbies	0.90 (9.7)	4	REQ				REQ	REQ	REQ	ADD2	ADD2
Locker Room	0.75 (8.1)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
Lounge/Breakroom											
… in a healthcare facility	0.92 (10.0)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
… all other lounges/breakrooms	0.73 (7.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Office											
… enclosed and ≤250 ft²(23.2 m²)	1.11 (12.0)	8	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	
… enclosed and >250 ft²(23.2 m²)	1.11 (12.0)	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… open plan	0.98 (10.6)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Parking Area, Interior	0.19 (2.1)	4	See Section 9.4.1.2.								
Pharmacy Area	1.68 (18.1)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Restroom											
… in an assisted living facility (and used primarily by residents)[3]	1.21 (13.1)	8	REQ				REQ	REQ		REQ	
… all other restrooms	0.98 (10.6)	8	REQ				REQ	REQ		REQ	
Sales Area[4]	1.59 (17.2)	6	REQ	ADD1	ADD1	REQ		REQ		ADD2	ADD2
Seating Area, General	0.54 (5.9)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Stairway			The space containing the stairway shall determine the LPD and control requirements for the stairway.								
Stairwell	0.69 (7.4)	10	REQ			REQ	REQ	REQ	REQ	ADD2	ADD2
Storage Room											
… <50 ft²(4.6 m²)	0.63 (6.8)	6	REQ	ADD1	ADD1		REQ	REQ	REQ	ADD2	ADD2
… ≥50 ft² (4.6 m²) and ≤ 1000 ft²(305 m²)	0.63 (6.8)	6	REQ	ADD1	ADD1		REQ	REQ		REQ	
… all other storage rooms	0.63 (6.8)	6	REQ	ADD1	ADD1		REQ	REQ	REQ	ADD2	ADD2
Vehicular Maintenance Area	0.67 (7.3)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Workshop	1.59 (17.2)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Building Type Specific Space Types[1]	LPD W/ft^2 (W/m^2)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Assisted Living Facility[3]											
… in a chapel (used primarily by residents)	2.21 (23.8)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a recreation room (used primarily by residents)	2.41 (26.0)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Automotive (See "Vehicular Maintenance Area")											
Convention Center—Exhibit Space	1.45 (15.7)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Dormitory—Living Quarters	0.38 (4.2)	8	REQ								
Fire Station—Sleeping Quarters	0.22 (2.4)	6	REQ								
Gymnasium/Fitness Center											
… in an exercise area	0.72 (7.8)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a playing area	1.20 (13.0)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Healthcare Facility											
… in an exam/treatment room	1.66 (18.0)	8	REQ			REQ	REQ	REQ		ADD2	ADD2
… in an imaging room	1.51 (16.3)	6	REQ			REQ				ADD2	ADD2
….in a medical supply room	0.74 (8.0)	6	(See "Storage Room" under "Common Space Types" for control requirements)								
… in a nursery	0.88 (9.5)	6	REQ			REQ	REQ	REQ		ADD2	ADD2
… in a nurse's station	0.71 (7.6)	6	REQ			REQ	REQ	REQ		ADD2	ADD2
… in an operating room	2.48 (26.8)	6	REQ			REQ				ADD2	ADD2
… in a patient room	0.62 (6.7)	6	REQ			REQ	REQ	REQ		ADD2	ADD2
… in a physical therapy room	0.91 (9.9)	6	REQ			REQ	REQ	REQ		ADD2	ADD2
… in a recovery room	1.15 (12.4)	6	REQ			REQ	REQ	REQ		ADD2	ADD2

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Building Type Specific Space Types[1]	LPD W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Library											
… in a reading area	1.06 (11.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in the stacks	1.71 (18.4)	4	REQ	ADD1	ADD1	REQ	REQ	REQ	REQ	ADD2	ADD2
Manufacturing Facility											
… in a detailed manufacturing area	1.29 (13.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in an equipment room	0.74 (8.0)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in an extra high bay area (>50 ft [15.2 m] floor-to-ceiling height)	1.05 (11.3)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a high bay area (25–50 ft [7.6–15.2 m] floor-to-ceiling height)	1.23 (13.3)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a low bay area (<25 ft [7.6 m] floor-to-ceiling height)	1.19 (12.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Museum											
… in a general exhibition area	1.05 (11.4)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a restoration room	1.02 (11.0)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Performing Arts Theater— Dressing Room	0.61 (6.6)	6	REQ	ADD1	ADD1	REQ	REQ	REQ		REQ	

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(continued)*

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1.
For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Building Type Specific Space Types[1]	LPD W/ft² (W/m²)	RCR Threshold	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	Bi-level Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Post Office—Sorting Area	0.94 (10.2)	4	REQ	ADD1	ADD1	REQ	REQ	REQ	REQ	ADD2	ADD2
Religious Buildings											
… in a fellowship hall	0.64 (6.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… in a worship/pulpit/choir area	1.53 (16.5)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Retail Facilities											
… in a dressing/fitting room	0.71 (7.7)	8	REQ	ADD1	ADD1	REQ		REQ		REQ	
… in a mall concourse	1.10 (11.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Sports Arena—Playing Area											
… for a Class I facility	3.68 (39.7)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… for a Class II facility	2.40 (25.9)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… for a Class III facility	1.80 (19.4)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
… for a Class IV facility	1.20 (13.0)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Transportation Facility											
… in a baggage/carousel area	0.53 (5.7)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
… in an airport concourse	0.36 (3.9)	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
… at a terminal ticket counter	0.80 (8.7)	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Warehouse—Storage Area											
…for medium to bulky, palletized items	0.58 (6.2)	4	REQ	ADD1	ADD1	REQ	REQ	REQ	REQ	ADD2	ADD2
… for smaller, hand-carried items[5]	0.95 (10.2)	6	REQ	ADD1	ADD1	REQ	REQ	REQ	REQ	ADD2	ADD2

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft (2.4 m).
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.

Modify Table 9.6.2 as follows (I-P and SI units).

TABLE 9.6.2 Control Factors Used in Calculating Additional Interior Lighting Power Allowance

Additional Control Method (in Addition to Mandatory Requirements).	Space Type				
	Open Office	Private Office	Conference Room, Meeting Room, Classroom (Lecture/ Training)	Retail Sales Area	Lobby, Atrium, Dining Area, Corridors/ Stairways, Gym/ Pool, Mall Concourse, Parking Garage
Manual, continuous dimming control or Programmable multi-level dimming control	0.05	0.05	0.10~~[1]~~	0.10	0
Programmable multi-level dimming control using programmable time scheduling	0.05	0.05	0.10~~[1]~~	0.10	0.10
~~Multi-level occupancy sensors~~	~~0.05~~	~~0.05~~	~~0.05~~	~~0~~	~~0~~
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off capabilities.	0.25[~~2~~1]	0	0	0	0
Occupancy sensors controlling the downlight component of workstation specific luminaires with continuous dimming to off operation, in combination with personal continuous dimming control of downlight illumination by workstation occupant.	0.30[~~2,3~~1, 2]	0	0	0	0
~~Automatic bi-level switching, or multi-level switching or continuous dimming in primary and secondary sidelighted areas when sidelighting effective aperture is greater than 0.15~~	~~0~~	~~0~~	~~0~~	~~0.104~~	~~0~~
~~Automatic bi-level switching, or multi-level switching or continuous dimming in primary sidelighted areas when sidelighting effective aperture is greater than 0.15 and when the controlled watts are less than 120W in the primary sidelighted area is less than 250 ft2 or less than 240W in combined primary and secondary sidelighted areas.~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~
~~Automatic continuous daylight dimming in primary sidelighted areas when sidelighting effective aperture is greater than 0.15 and when primary sidelighted area is less than 250 ft2~~	~~0.204~~	~~0.204~~	~~0.204~~	~~0.204~~	~~0.204~~
~~Automatic continuous daylight dimming in primary sidelighted areas when sidelighting effective aperture is greater than 0.15 and when primary sidelighted area is greater than 250 ft2~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~
Automatic continuous daylight dimming in secondary sidelighted areas	0.10[3]	0.10[3]	0.10[3]	0.10[3]	0.10[3]
~~Automatic continuous daylight dimming in secondary sidelighted areas when sidelighting effective aperture is greater than 0.3~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~	~~0.104~~
~~Automatic continuous daylight dimming in daylight areas under skylights when the total of those areas is less than 900 ft2 when the controlled watts are less than 120W and when the skylight visible transmittance (VT) is greater than 0.4~~	~~0.20~~	~~0.20~~	~~0.20~~	~~0.20~~	~~0.20~~
~~Automatic continuous daylight dimming in daylight areas under skylights when the total of those areas is greater than 900 ft2 and when skylight effective aperture is greater than 0.01~~	~~0.10~~	~~0.10~~	~~0.10~~	~~0.10~~	~~0.10~~

~~1. These control factors may only be used if the requirements of section 9.4.1.2 are met using an occupancy sensor.~~

~~2.~~1. Control factor is limited to the wattage of workstation-specific luminaires in partitioned single occupant workspaces contained within an open office environment (i.e. direct-indirect luminaires with separately controlled downlight and uplight components, with the downward component providing illumination to a single occupant in an open plan workstation). Within 30 minutes of the occupant leaving the space, the downward component shall continuously dim to off over a minimum of 2 minutes. Upon the occupant entering the space, the downward component shall turn on at the minimum level and continuously raise the illumination to a preset level over a minimum of 30 seconds. The uplight component of workstation specific luminaire shall comply with Section 9.4.1.1(h) (automatic full off~~shutoff~~).

~~3.~~2. In addition to the requirements described in footnote 2, the control shall allow the occupant to select their preferred light level via a personal computer, handheld device, or similarly accessible device located within the workstation.

~~4.~~3. Control factors may not be used if controls are used to satisfy exceptions to Section 5.5.4.2.3.

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FOREWORD

Vestibules are installed to reduce infiltration into the building. The benefit of a vestibule during the heating season is negated if the vestibule is heated to the heating setpoint of the adjacent space. At the same time, tempering of vestibule air is needed to avoid ice formation. A major retailer has reported that they temper vestibule air to 40°F (4.4°C).

This addendum requires that vestibule heating be locked out when outside air is above 45°F (7°C), the same temperature required in Section 6.4.3.8 for lockout of freeze protection or ice melting systems . An exception is allowed when the vestibule is unheated or tempered with transfer air rather than directly heated. Transfer air heating is beneficial because that conditioned air is destined to be exhausted anyway, and pressurizing the vestibule may reduce infiltration further.

Air curtains are also covered, as significant heating energy can be expended if air curtain heating operates unnecessarily.

The phrase "configured to" is used instead of "capable of." The word "capable" is not the best mandatory language for controls, as control equipment can be provided that could be said to be capable of achieving the desired result even though the setpoint is not correct or the programming is not complete. Using "configured" implies that all programming is complete and setpoints correct, yet focuses on the present state at time of inspection rather than on future operation.

Cost effectiveness represents a minor additional requirement, and where there is DDC control, there is no additional cost to add outside air lockout to vestibule heating control. Where vestibule heating is separately controlled, limiting the setpoint to 45°F (7°C) meets the requirements without any additional cost.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ca to Standard 90.1-2010

Add a new Section 6.4.3.9 and renumber existing section 6.4.3.9 and following sections (I-P and SI units).

6.4.3.9 Heating for vestibules, in accordance with Section 5.4.3.4, and air curtains shall include automatic controls configured to shut off the heating system when outdoor air temperatures are above 45°F (7°C). Vestibule heating systems shall also be controlled by a thermostat in the vestibule with a setpoint limited to a maximum of 60°F (16°C).

Exception: Vestibules with no heating system or that are tempered with transfer air that would otherwise be exhausted.

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FOREWORD

Optimum start is an energy saving control sequence, commonly available in DDC systems and most commercial programmable thermostats. It is currently required in air-based systems larger than 10,000 cfm. Unfortunately, optimum start is likely one of the most disabled options in control systems. Disabling occurs because facility operators may not trust the automated algorithms used, may not be interested in taking the time to properly tune or set up the system, or may have had an experience of optimum start failing to warm up or cool down a space by the occupied time. In unitary system control, most programmable thermostats use only space temperature to determine optimum start. Whether they have internal learning algorithms or they use a set response related to design conditions, these systems will eventually fail to achieve the desired space temperature by occupancy start due to a cold snap. The space-temperature-only optimum start approaches will fail because the setback temperature is maintained by the system, and a space temperature at the setback condition gives no indication of the larger startup load required when outdoor conditions are extreme.

Introducing outdoor air temperature as one of the parameters in an optimum start algorithm will allow systems to start earlier during extreme outdoor conditions, and avoid space-not-at-temperature occurrences that result from current optimum start algorithms based only on time and space temperature. This will improve reliability and acceptance of optimum start, resulting in more energy savings throughout the year, even if optimum start is suspended during extreme conditions. Implementing the outdoor air input in a DDC system is readily achievable without any new technology, and can be implemented either with or without a learning algorithm.

At this time, only one manufacturer was found who provided a (noncustomizable) programmable thermostat using optimum start with outdoor air input, so it is unreasonable to require thermostats to have this feature at this time in a minimum efficiency standard.

This addendum removes the 10,000 cfm threshold for optimum start and adds a threshold for systems controlled by DDC. The addendum also expands the requirement beyond air-based systems so that convectors and radiant systems are included. Language is added to make clear that optimum start is only required for systems with setback control requirements.

Radiant heating systems are currently exempt from setback requirements. While it is true that radiant systems take longer to recover space temperature, a modest setback can provide significant savings and a period of off time daily for boilers and distribution systems, especially in mild weather. Multiple manufacturers make radiant thermostats with setback capability that includes floor sensors to avoid overshoot of heating after warm up. The radiant heat exception to setback is revised to allow a smaller heating setback as is appropriate for radiant systems.

The cooling setback language is revised to apply to mechanical cooling so that air or water economizer cooling can be used to maintain occupied cooling setpoints or precool the space during unoccupied periods. An exception for mechanical precooling for load shifting is added, as the current mandatory provision would not allow such a strategy. Should a mechanical precooling strategy be desired for demand reduction or time/load shifting, it is appropriate to conduct a specific building simulation to verify that the proposed approach provides a performance benefit for the particular situation, so an analysis is required for this exception.

The phrase "that have the capability" is changed to "configured" throughout. The word "capable" is not the best mandatory language for controls, as control equipment can be provided that could be said to be capable of achieving the desired result even though the setpoint is not correct or the programming is not even complete. Using "configured" implies that all programming is complete and setpoints correct, yet focuses on the present state at the time of inspection rather than future operation.

This represents a minor shift in an existing requirement, and since optimum start would only be required for DDC systems that typically have readily available standard sequences for optimum start, there is no significant additional cost to implementing optimum start for additional systems with a DDC system. The floor sensor requirement for radiant floors is a minor cost in new construction, and a floor sensor is often used in standard practice for a mass floor radiant application.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cb to Standard 90.1-2010

Revise the standard as follows (I-P and SI Units)

6.4.3.3.2 Setback Controls. Heating systems ~~located in climate zones 2–8~~ shall be equipped with controls ~~that have the capability~~ configured to automatically restart and temporarily operate the system as required to maintain zone temperatures above an adjustable heating setpoint ~~adjustable down to 55°F or lower~~ at least 10°F (5.6°C) below the occupied heating setpoint. Cooling systems ~~located in climate zones 1b, 2b, and 3b~~ shall be equipped with controls ~~that have the capability~~ configured to automatically restart and temporarily operate the mechanical cooling system as required to maintain zone temperatures below an adjustable cooling setpoint ~~adjustable up to 90°F or higher~~ at least 5°F (2.8°C) above the occupied cooling setpoint or to prevent high space humidity levels.

Exception: Radiant ~~floor and ceiling~~ heating systems configured with a setback heating setpoint at least 4°F (2°C) below the occupied heating setpoint

6.4.3.3.3 Optimum Start Controls. Individual heating and cooling ~~air distribution~~ systems with setback controls and DDC ~~with a total design supply air capacity exceeding 10,000 cfm, served by one or more supply fans,~~ shall have optimum start controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature into the optimum start algorithm.

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FOREWORD

Evaporatively cooled heat rejection devices are key components of the most efficient refrigeration and HVAC systems on the market. Addendum bp, which added minimum efficiency for evaporative condensers used in ammonia applications, recently passed its public review period with no comments and is expected to be included in the 2013 edition of Standard 90.1.

Although the majority of evaporative condenser applications are ammonia based, a significant number of refrigeration systems are applied using halocarbon refrigerants. To accommodate these applications, this addendum adds minimum efficiencies for both axial and centrifugal fan evaporative condensers with R-507A as the test fluid to Table 6.8.1G. Because of the numerous halocarbon refrigerants that can be utilized, a footnote has been added to the table that clarifies that evaporative condenser models intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.

This addendum is supported by the Standards subcommittee of ASHRAE TC08.06 for Cooling Towers and Evaporative Condensers and the Air-Cooled and Evaporative Condensers (ACEC) subsection of the Air-Conditioning, Heating and Refrigeration Institute (AHRI).

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cc to Standard 90.1-2010

Revise the standard as follows for I-P and SI units, respectively.

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment (I-P)

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition[h]	Performance Required[a,b,c,d, f, g]	Test Procedure[e]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	102°F entering water 90°F leaving	≥7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥134,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥110,000 Btu/h·hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥157,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥135,000 Btu/h·hp	CTI ATC-106
Air-cooled condensers	All	125°F condensing temperature 190°F entering gas temperature 15°F subcooling 95°F entering db	≥176,000 Btu/h·hp69 COP	AHRI 460

a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan motor nameplate power.
b. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
c. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
d. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
e. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections.
f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project specific accessories and/or options included in the capacity of the cooling tower.
g. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
h. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed above with R-507A as the test fluid.

TABLE 6.8.1G Performance Requirements for Heat Rejection Equipment (SI)

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition[h]	Performance Required[a,b,c,d, f, g]	Test Procedure[e]
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥3.23 L/s·kW	CTI ATC-105 and CTI STD-201
Centrifugal fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥1.7 L/s·kW	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥1.18 L/s·kW	CTI ATC-105S and CTI STD-201
Centrifugal closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥0.59 L/s·kW	CTI ATC-105S and CTI STD-201
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 60°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥52.6 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 60°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥43.2 COP	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°F entering wb	≥61.6 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	≥53.0 COP	CTI ATC-106
Air-cooled condensers	All	2°C condensing temperature 88°C entering gas temperature 8°C subcooling 35°C entering db	≥69 COP	AHRI 460

a. For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the fan motor nameplate power.

b. For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the thermal rating condition listed in Table 6.8.1G divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

c. For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

d. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

e. The efficiencies and test procedures for both open- and closed-circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections.

f. All cooling towers shall comply with the minimum efficiency listed in the table for that specific type of tower with the capacity effect of any project specific accessories and/or options included in the capacity of the cooling tower.

g. For purposes of this table, evaporative condenser performance is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

h. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed above with R-507A as the test fluid.

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FOREWORD

In the current standard, "piping" is required to have minimum levels of insulation, minimum pipe sizes, etc. In all cases, the intent was that the same requirements also apply to all of the piping accessories that are in series with the piping that also sees fluid flow, such as pumps, valves, strainers, air separators, etc., but the dictionary and ASHRAE definitions of "piping" do not clearly include these elements. Other piping system accessories that are not in series with the piping circuit, such as expansion tanks, fill lines, chemical feeders, and drains, were not intended to be included because they do not have the same heat losses/gains and pressure drop. This addendum is intended to make this distinction clear.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cd to Standard 90.1-2010

Add the following definition to Chapter 3 (I-P and SI units).

<u>***piping:*** the pipes or tubes interconnecting the various parts of a fluid distribution system, including all elements that are in series with the fluid flow, such as pumps, valves, strainers, and air separators, but not including elements that are not in series with the fluid flow, such as expansion tanks, fill lines, chemical feeders, and drains.</u>

Change "pipe" to "piping" in various locations in the Standard where the intent was to cover the entire piping system not just pipes (SI and I-P units). (Note: not all uses of "pipe" are replaced, only those that are substantive with respect to requirements in the standard.)

[. . .]

6.1.1.3.5 New and replacement piping shall comply with Section 6.4.4.1.

Exceptions: Compliance shall not be required:

[. . .]

e. for ducts and ~~pipes~~ <u>piping</u> where there is insufficient space or access to meet these requirements.

[. . .]

6.5.4.5 Pipe Sizing. All chilled-water and condenser water piping shall be designed such that the design flow rate in each ~~pipe~~<u>piping</u> segment shall not exceed the values listed in Table 6.5.4.5 for the appropriate total annual hours of operation. ~~Pipe~~<u>Piping</u> size selections for systems that operate under variable flow conditions (e.g., modulating two-way control valves at coils) and that contain variable-speed pump motors are allowed to be made from the "Variable Flow/Variable Speed" columns. All others shall be made from the "Other" columns.

Exceptions:

a. Design flow rates exceeding the values in Table 6.5.4.5 are allowed in specific sections of ~~pipe~~<u>piping</u> if the ~~pipe~~<u>piping</u> in question is not in the critical circuit at design conditions and is not predicted to be in the critical circuit during more than 30% of operating hours.
b. Piping systems that have equivalent or lower total pressure drop than the same system constructed with standard weight steel pipe with piping and fittings sized per Table 6.5.4.5.

[. . .]

7.4.3 Service Hot-Water Piping Insulation. The following piping shall be insulated to levels shown in Section 6, Table 6.8.3:

a. Recirculating system piping, including the supply and return piping of a circulating tank type water heater
b. The first 8 ft of outlet piping for a constant temperature nonrecirculating storage system
c. The inlet ~~pipe~~<u>piping</u> between the storage tank and a heat trap in a nonrecirculating storage system
d. ~~Pipes~~<u>Piping</u> that ~~are~~ <u>is</u> externally heated (such as heat trace or impedance heating)

TABLE 6.8.3A Minimum ~~Pipe~~Piping Insulation Thickness Heating and Hot Water Systems[a,b,c,d] (Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems) (I-P and SI)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu·in./(h·ft²·°F)	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness (in.)				
[. . .]							

TABLE 6.8.3B Minimum ~~Pipe~~Piping Insulation Thickness Heating and Hot Water Systems[a,b,c,d] (Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems) (I-P and SI)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu·in./(h·ft²·°F)	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness (in.)				
[. . .]							

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FOREWORD

This addendum establishes package single-zone systems as the baseline HVAC system type for all retail occupancies of two stories or fewer. Prior to this change, large retail facilities would have VAV reheat baseline systems, which are not at all common in that building type. This change sets a more realistic baseline building HVAC system.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ce to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

TABLE G3.1.1A Baseline HVAC System Types

Building Type	Fossil Fuel, Fossil/Electric Hybrid, and Purchased Heat	Electric and Other
Residential Nonresidential and 3 floors or fewer and <25,000 ft^2	System 1—PTAC System 3—PSZ-AC	System 2—PTHP System 4—PSZ-HP
Nonresidential and 4 or 5 floors and <25,000 ft^2 or 5 floors or fewer and 25,000 ft^2 to 150,000 ft^2 Nonresidential and more than 5 floors or >150,000 ft^2	System 5—Packaged VAV with reheat System 7—VAV with reheat	System 6—Packaged VAV with PFP boxes System 8—VAV with PFP boxes
Heated-only storage	System 9—Heating and ventilation	System 10—Heating and ventilation
Retail and 2 floors or fewer	System 3—PSZ-AC	System 4—PSZ-HP

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FOREWORD

Addendum f established baseline building window-to-wall ratios for different building types in Appendix G. Based on limited data available at the time, a value only applicable to stand-alone retail buildings was established. Since that time new data have become available that has enabled the establishment of a window-to-wall ratio for retail strip-mall buildings, which is added in this current addendum.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cf to Standard 90.1-2010

Revise Table G3.3 as follows (I-P and SI units).

TABLE G3.3 Baseline Building Vertical Fenestration Percentage of Gross Above-Grade-Wall Area

Building Area Types[a]	Baseline Building Gross above Grade Wall Area
Grocery Store	7%
Healthcare (outpatient)	21%
Hospital	27%
Hotel/motel (≤75 rooms)	24%
Hotel/motel (>75 rooms)	34%
Office ((≤5000 ft^2 [≤465 m^2])	19%
Office (5000–50,000 ft^2 [465–4650 m^2])	31%
Office (>50,000 ft^2 [>4650 m^2])	40%
Restaurant (quick service)	34%
Restaurant (full service)	24%
Retail (stand alone)	11%
<u>Retail (strip mall)</u>	<u>20%</u>
School (primary)	22%
School (secondary and university)	22%
Warehouse (nonrefrigerated)	6%

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

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FOREWORD

The addendum makes several changes to the requirements for chillers.

Change 1

This addendum makes changes to the requirements for air- and water- cooled chillers as defined in Section 6.4.2.1 and the efficiency requirements listed in table 6.8.1C. This change is a continuation of the efficiency improvements that were implemented in 2010 by further improving the efficiency requirements. In 2010 a Path B was added for part-load intensive water-cooled chillers. This change also expands Path B by adding requirements to include air-cooled chillers. Also, as part of this change, efforts were made to bring the efficiency requirements for water-cooled positive displacement and centrifugal chillers together while considering the available technology and that chillers can be applied at other application conditions where one technology may better suited than the other. The new efficiency requirements will go into effect on 1/1/2015.

In 2010, the overall weighted average savings resulted in a 16.2% improvement in chiller annualized energy use as compared to ASHRAE/IESNA Standard 90.1-2004. The new addendum efficiency requirements extend the savings to 23.1% as compared to Standard 90.1-2004 and 8.3% as compared to ASHRAE/IES Standard 90.1-2010. All the efficiency categories reduced the annual energy use; for the <150 ton (528 kW) centrifugal category the full load decreased slightly, but the improvements in IPLV resulted in overall annual energy savings. The <75 ton (263 kW) and <150 ton (528 kW) categories are new categories for centrifugal, which previously was <300 tons (1055 kW).

A detailed economic analysis has been completed, and the average payback period of 6.3 years has been calculated, but some units exceed the scalar limits.

Change 2

Improvements have been made to the efficiency change requirements to clarify their use. AHRI has recently updated the AHRI 550/590 standard used for the rating of chillers and the certification program. As part of this, they developed a hard metric rating standard with slightly different rating conditions than those for I-P units and released it as AHRI 551/591. This change for SI units is now reflected in the ratings, and the reference to the AHRI rating standard has been revised to include AHRI 551/591.

Change 3

Due in part to IC 90.1-2010-14, and the fact that high-lift, heat reclaim chiller applications often use a different compressor (and sometimes a different refrigerant), it is requested that Standard 90.1 exclude high-temperature heat reclaim chillers from the equipment efficiency requirements of Table 6.8.1C when the leaving condenser temperatures are greater than 115 °F (46°C). The intention of using heat reclaim chillers is to increase system efficiency, but this effect on overall system efficiency cannot be judged by its efficiency at standard cooling design conditions.

AHRI Standard 550/590 was updated in 2011, and the update now allows chillers with water-cooled condensers to have heat reclaim application ratings up to 160 °F (71°C) leaving condenser fluid temperatures. The older version of Standard 550/590 excluded water-cooled chillers with entering condenser fluid temperatures above 105°F (41°C). A leaving condenser temperature of 115°F (46°C) would be a common expectation of this equipment when the entering temperature is 105°F (41°C).

Because ASHRAE/IES Standard 90.1-2013 will reference the newer, 2011 version of AHRI Standard 550/590, we must add a high limit on the efficiency table until new efficiency requirements can be generated for high-lift heat reclaim chiller equipment.

This creates a simplification for designers, since the 115°F leaving condenser temperature limit would be common to both centrifugal and positive displacement chillers.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ch to Standard 90.1-2010

Revise Section 12 as shown (I-P and SI units).

Reference	Title
Air Conditioning, Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201	
AHRI 550/590-2011 (IP) and AHRI 551/591 (SI)	Performance Rating of Water-Chilling and Heat-Pump Water-Heating Packages Using the Vapor Compression Cycle

Revise Section 6 as follows and delete the current Table 6.8.1C and replace it with the table provided (I-P units).

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 Water-Cooled Centrifugal Chilling Packages. Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F leaving chilled-fluid temperature and 2.4 gpm/ton evaporator fluid flow and 85°F entering condenser-fluid temperature with 3.0 gpm/ton condenser-fluid flow (and, thus, cannot be tested to meet the requirements of Table 6.8.1C) shall have maximum full-load kW/ton (FL) and ~~NPLV~~ part-load ratings~~s~~ requirements adjusted using the following equations:

~~Adjusted maximum full-load kW/ton rating = (full-load kW/ton from Table 6.8.1C/K_{adj})~~

~~Adjusted maximum NPLV rating = IPLV from Table 6.8.1C/K_{adj})~~

$$FL_{adj} = FL/K_{adj}$$

$$PLV_{adj} = IPLV/K_{adj}$$

$$K_{adj} = A \times B$$

where

FL	=	full-load kW/ton value from Table 6.8.1C
FL_{adj}	=	maximum full-load kW/ton rating, adjusted for nonstandard conditions
IPLV	=	IPLV value from Table 6.8.1C
PLV_{adj}	=	maximum NPLV rating, adjusted for nonstandard conditions
A	=	$0.00000014592 \times (\text{LIFT})^4 - 0.0000346496 \times (\text{LIFT})^3 + 0.00314196 \times (\text{LIFT})^2 - 0.147199 \times (\text{LIFT}) + 3.9302$
B	=	$0.0015 \times \text{LvgEvap} + 0.934$
LIFT	=	LvgCond – LvgEvap
LvgCond	=	full-load condenser leaving fluid temperature, °F
LvgEvap	=	full-load evaporator leaving temperature, °F

The ~~adjusted full-load~~FL_{adj} and ~~N~~PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum Evaporator Leaving Temperature:36°F
- Maximum Condenser Leaving Temperature:115°F
- ~~LIFT ≥ 20°F and ≤ 80°F~~ 20°F ≤ LIFT ≤ 80°F

Manufacturers shall calculate the ~~adjusted maximum kW/ ton~~ FL_{adj} and ~~N~~PLV_{adj} before determining whether to label the chiller per Section 6.4.1.5. Compliance with Standard 90.1-2007, ~~or~~ 2010, 2013, or ~~both~~ combinations thereof shall be labeled on chillers within the scope of the standard.

Centrifugal chillers designed to operate outside of these ranges are not covered by this standard.

Example: Path A 600 ton centrifugal chiller Table 6.8.1C efficiencies effective 1/1/2015:

~~Full Load~~FL	=	~~0.570~~0.560 kW/ton
IPLV	=	~~0.539~~0.500 kW/ton
LvgCond	=	91.16°F
LvgEvap	=	42.00°F
LIFT	=	91.16 – 42.00 = 49.16°F
K_{adj}	=	A × B
A	=	$0.00000014592 \times (49.16)^4 - 0.0000346496 \times (49.16)^3 + 0.00314196 \times (49.16)^2 - 0.147199 \times (49.16) + 3.9302 = 1.0228$
B	=	$0.0015 \times 42.00 + 0.934 = 0.9970$

~~Adjusted full load~~ FL_{adj} = ~~0.570~~0.560/(1.0228 × 0.9970) = ~~0.559~~0.549 kW/ton

~~N~~PLV_{adj} = ~~0.539~~0.500/(1.0228 × 0.9970) = ~~0.529~~0.490 kW/ton

6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 32°F and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 115°F shall show compliance with Table 6.8.1C when tested or certified with water at standard rating conditions, per the referenced test procedure.

TABLE 6.8.1C Water-Chilling Packages—Efficiency Requirements[a,b,e]

Equipment Type	Size Category	Units	Effective 1/1/2010 Path A	Effective 1/1/2010 Path B	Effective 1/1/2015 Path A	Effective 1/1/2015 Path B	Test Procedure[c]
Air-cooled chillers	<150 tons	EER (Btu/W)	≥9.562 FL	NA[d]	≥10.100 FL	≥9.700 FL	AHRI 550/590
			≥12.500 IPLV		≥13.700 IPLV	≥15.800 IPLV	
	≥150 tons		≥9.562 FL	NA[d]	≥10.100 FL	≥9.700 FL	
			≥12.750 IPLV		≥14.000 IPLV	≥16.100 IPLV	
Air-cooled without condenser, electrically operated	All capacities	EER (Btu/W)	Air-cooled chillers without condenser must be rated with matching condensers and comply with air-cooled chiller efficiency requirements				
Water-cooled, electrically operated positive displacement	<75 tons	kW/ton	≤0.780 FL	≤0.800 FL	≤0.750 FL	≤0.780 FL	
			≤0.630 IPLV	≤0.600 IPLV	≤0.600 IPLV	≤0.500 IPLV	
	≥75 tons and <150 tons		≤0.775 FL	≤0.790 FL	≤0.720 FL	≤0.750 FL	
			≤0.615 IPLV	≤0.586 IPLV	≤0.560 IPLV	≤0.490 IPLV	
	≥150 tons and < 300 tons		≤0.680 FL	≤0.718 FL	≤0.660 FL	≤0.680 FL	
			≤0.580 IPLV	≤0.540 IPLV	≤0.540 IPLV	≤0.440 IPLV	
	≥300 tons and < 600 tons		≤0.620 FL	≤0.639 FL	≤0.610 FL	≤0.625 FL	
			≤0.540 IPLV	≤0.490 IPLV	≤0.520 IPLV	≤0.410 IPLV	
	≥600 tons		≤0.620 FL	≤0.639 FL	≤0.560 FL	≤0.585 FL	
			≤0.540 IPLV	≤0.490 IPLV	≤0.500 IPLV	≤0.380 IPLV	
Water cooled, electrically operated centrifugal	<150 tons	kW/ton	≤0.634 FL	≤0.639 FL	≤0.610 FL	≤0.695 FL	
			≤0.596 IPLV	≤0.450 IPLV	≤0.550 IPLV	≤0.440 IPLV	
	≥150 tons and <300 tons		≤0.634 FL	≤0.639 FL	≤0.610 FL	≤0.635 FL	
			≤0.596 IPLV	≤0.450 IPLV	≤0.550 IPLV	≤0.400 IPLV	
	≥300 tons and <400 tons		≤0.576 FL	≤0.600 FL	≤0.560 FL	≤0.595 FL	
			≤0.549 IPLV	≤0.400 IPLV	≤0.520 IPLV	≤0.390 IPLV	
	≥400 tons and <600 tons		≤0.576 FL	≤0.600 FL	≤0.560 FL	≤0.585 FL	
			≤0.549 IPLV	≤0.400 IPLV	≤0.500 IPLV	≤0.380 IPLV	
	≥600 tons		≤0.570 FL	≤0.590 FL	≤0.560 FL	≤0.585 FL	
			≤0.539 IPLV	≤0.400 IPLV	≤0.500 IPLV	≤0.380 IPLV	
Air-cooled absorption, single effect	All capacities	COP	≥0.600 FL	NA[d]	≥0.600 FL	NA[d]	AHRI 560
Water-cooled absorption, single effect	All capacities	COP	≥0.700 FL	NA[d]	≥0.700 FL	NA[d]	
Absorption double-effect, indirect-fired	All capacities	COP	≥1.000 FL	NA[d]	≥1.000 FL	NA[d]	
			≥1.050 IPLV		≥1.050 IPLV		
Absorption double-effect, direct-fired	All capacities	COP	≥1.000 FL	NA[d]	≥1.000 FL	NA[d]	
			≥1.000 IPLV		≥1.000 IPLV		

a. ~~The centrifugal chiller equipment requirements after adjustment per 6.4.1.2 do not apply to chillers where the design leaving evaporator temperature is < 36°F. The requirements do not apply to positive displacement chillers with design leaving fluid temperatures ≥32°F. The requirements do not apply to absorption chillers with design leaving fluid temperatures < 40°F.~~ The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed there. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.
b. ~~Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or Path B.~~ Both the full-load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.
c. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
d. ~~NA means that this requirement is not applicable and cannot be used for compliance.~~ NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.
e. FL is the full-load performance requirements, and IPLV is for the part-load performance requirements.

Revise Section 6 as follows and delete the current Table 6.8.1C and replace it with the table provided (SI units).

6.4.1.2 Minimum Equipment Efficiencies—Listed Equipment—Nonstandard Conditions

6.4.1.2.1 Water-Cooled Centrifugal Chilling Packages. Equipment not designed for operation at AHRI Standard ~~550/590~~ 551/591 test conditions of ~~6.7~~7.0°C leaving and 12.0 C° entering chilled-fluid temperatures, and with ~~29.4~~30.0°C entering and 35.0°C leaving condenser-fluid temperatures ~~with 0.054 L/s·kW condenser-fluid flow~~ (whereby they cannot be tested to meet the requirements of Table 6.8.1C) shall have maximum full-load (FL) COP and ~~*NPLV*~~ part-load ratings requirements adjusted using the following equations:

~~Adjusted maximum full-load kW/ton rating = (full-load COP from Table 6.8.1C ×~~ ~~K_{adj})~~

~~Adjusted maximum NPLV rating = IPLV from Table 6.8.1C ×~~ ~~K_{adj})~~

$$FL_{adj} = FL \times K_{adj}$$

$$PLV_{adj} = IPLV \times K_{adj}$$

$$K_{adj} = A \times B$$

where

FL	=	full-load COP value from Table 6.8.1C
FL_{adj}	=	minimum full-load COP rating, adjusted for nonstandard conditions
IPLV	=	IPLV value from Table 6.8.1C
PLV_{adj}	=	minimum NPLV rating, adjusted for nonstandard conditions
A	=	$0.0000015318 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times (LIFT) + 3.9302196$
B	=	$0.0027 \times LvgEvap + 0.982$
LIFT	=	LvgCond – LvgEvap
LvgCond	=	full-load condenser leaving fluid temperature, °C
LvgEvap	=	full-load evaporator leaving temperature, °C

The ~~adjusted full-load~~FL_{adj} and ~~N~~PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum Evaporator Leaving Temperature: ~~2.2~~2.0°C
- Maximum Condenser Leaving Temperature: ~~46.1~~46°C
- ~~LIFT ≥ 11.0°C and ≤44.0°C~~11.0°C ≤ LIFT ≤ 44.0°C

Manufacturers shall calculate the ~~adjusted minimum COP~~ FL_{adj} and ~~N~~PLV_{adj} before determining whether to label the chiller per Section 6.4.1.5. Compliance with Standard 90.1-2007~~,~~ ~~or~~ 2010, 2013 or ~~both~~ combinations thereof shall be labeled on chillers within the scope of the standard.

Centrifugal chillers designed to operate outside of these ranges are not covered by this standard.

Example: Path A 2110 kW centrifugal chiller Table 6.8.1C efficiencies effective 1/1/2015:

~~Full Load~~FL	=	~~6.170~~6.286 COP
IPLV	=	~~6.525~~7.041 COP
LvgCond	=	37.00°C
LvgEvap	=	~~7~~6.00°C
LIFT	=	37.00 – ~~7~~6.00 = 31.00°C
K_{adj}	=	$A \times B$
A	=	0.0000015318 × $(30.0)^4$ – 0.000202076 × $(30.0)^3$ + 0.0101800 × $(30.0)^2$ – 0.264958 × 30.0 + 3.93~~0~~2196 = 0~~.9282.~~9302
B	=	0.0027 × ~~7.0~~6.00 + 0.98~~2~~11 = ~~1.0009~~0.9973

~~Adjusted full load COP~~FL_{adj} = ~~6.170~~6.286 × ~~0.9282~~ 0.9302× ~~1.0009~~0.9973 = ~~5.732~~5.831 COP

~~Adjusted N~~PLV_{adj} = ~~6.525~~7.041 ~~× 0.9282~~0.9302 × ~~1.0009~~0.9973 = ~~5.53~~6.531 COP

6.4.1.2.2 Positive Displacement (Air- and Water-Cooled) Chilling Packages. Equipment with an evaporator leaving fluid temperature higher than 0°C and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 46°C shall show compliance with Table 6.8.1C when tested or certified with water at standard rating conditions, per the referenced test procedure.

TABLE 6.8.1C Water-Chilling Packages—Efficiency Requirements[a,b,e]

Equipment Type	Size Category	Units	Effective 1/1/2010 Path A	Effective 1/1/2010 Path B	Effective 1/1/2015 Path A	Effective 1/1/2015 Path B	Test Procedure[c]
Air-cooled chillers	<528 kW	COP (W/W)	≥2.826 FL	NA[d]	≥2.985FL	≥2.866 FL	AHRI 551/591
			≥3.694 IPLV		≥4.048 IPLV	≥4.669 IPLV	
	≥528 kW		≥2.826 FL	NA[d]	≥2.985 FL	≥2.866 FL	
			≥3.768 IPLV		≥4.137 IPLV	≥4.758 IPLV	
Air-cooled without condenser, electrically operated	All capacities	COP (W/W)	Air-cooled chillers without condenser must be rated with matching condensers and comply with air-cooled chiller efficiency requirements				
Water-cooled, electrically operated positive displacement	<264 kW	COP (W/W)	≥4.513 FL	≥4.400 FL	≥4.694 FL	≥4.513 FL	
			≥ 5.588 FL	≥5.867 IPLV	≥5.867 IPLV	≥7.041 IPLV	
	≥264 kW and <528 kW		≥4.542 FL	≥4.456 FL	≥4.889 FL	≥4.694 FL	
			≥ 5.724 IPLV	≥6.007 IPLV	≥6.286 IPLV	≥7.184 IPLV	
	≥528 kW and <1055 kW		≥5.177 FL	≥4.903 FL	≥5.334 FL	≥5.177 FL	
			≥6.070 IPLV	≥6.519 IPLV	≥6.519 IPLV	≥8.001 IPLV	
	≥1055kW and <2110 kW		≥5.678 FL	≥5.509 FL	≥5.771 FL	≥5.633 FL	
			≥6.519 IPLV	≥7.184 IPLV	≥6.770 IPLV	≥8.586IPLV	
	≥2100 kW		≥5.678 FL	≥ 5.509 FL	≥6.286 FL	≥6.018 FL	
			≥6.519 IPLV	≥7.184 IPLV	≥7.041 IPLV	≥9.264 IPLV	
Water-cooled, electrically operated centrifugal	<528 kW	COP (W/W)	≥5.553 FL	≥5.509 FL	≥5.771 FL	≥5.065 FL	
			≥5.907 IPLV	≥7.823 IPLV	≥6.401 IPLV	≥8.001 IPLV	
	≥528 kW and <1055 kW		≥5.553 FL	≥5.509 FL	≥5.771 FL	≥5.544 FL	
			≥5.907 IPLV	≥7.823 IPLV	≥6.401 IPLV	≥8.801 IPLV	
	≥1055 kW and <1407kW		≥6.112 FL	≥5.867 FL	≥6.286 FL	≥5.917 FL	
			≥6.412 IPLV	≥8.801 IPLV	≥6.770 IPLV	≥9.027 IPLV	
	≥1407 kW and <2110 kW		≥6.112 FL	≥5.867 FL	≥6.286 FL	≥6.018 FL	
			≥6.412 IPLV	≥8.801 IPLV	≥7.041 IPLV	≥9.264 IPLV	
	≥2110 kW		≥6.176 FL	≥5.967 FL	≥6.286 FL	≥6.018 FL	
			≥6.531 IPLV	≥8.801 IPLV	≥7.041 IPLV	≥9.264 IPLV	
Air-cooled absorption, single effect	All capacities	COP (W/W)	≥0.600 FL	NA[d]	≥0.600 FL	NA[d]	AHRI 560
Water-cooled absorption, single effect	All capacities	COP (W/W)	≥0.700 FL	NA[d]	≥0.700 FL	NA[d]	
Absorption double-effect, indirect-fired	All capacities	COP (W/W)	≥1.000 FL	NA[d]	≥1.000 FL	NA[d]	
			≥1.050 IPLV		≥1.050 IPLV		
Absorption double-effect, direct-fired	All capacities	COP (W/W)	≥1.000 FL	NA[d]	≥1.000 FL	NA[d]	
			≥1.000 IPLV		≥1.000 IPLV		

a. ~~The centrifugal chiller equipment requirements after adjustment per 6.4.1.2 do not apply to chillers where the design leaving evaporator temperature is < 2.2°C. The requirements do not apply to positive displacement chillers with design leaving fluid temperatures ≥0°C. The requirements do not apply to absorption chillers with design leaving fluid temperatures < 4.4°C~~.The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Standard 6.4.1.2.1 and are only applicable for the range of conditions listed there. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. ~~Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However, both the full load and IPLV must be met to fulfill the requirements of Path A or Path B.~~Both the full-load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

c. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

d. ~~NA means that this requirement is not applicable and cannot be used for compliance.~~ NA means the requirements are not applicable for Path B, and only Path A can be used for compliance.

e. FL is the full-load performance requirements and IPLV is for the part-load performance requirements.

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

FOREWORD

With the adoption of addendum aq, data centers can no longer claim the process exemption and are now clearly covered by 90.1. Therefore it was necessary to include a reasonable base case, or "standard of care," for data centers in Appendix G. Many data center experts, including several members of ASHRAE TC 9.9, participated in drafting this proposal. The consensus among these experts was that a reasonable base case for small data centers is air-cooled packaged computer room air-conditioning units (CRACs), and a reasonable base case for large data centers is chilled-water computer room air handlers (CRAHs) with variable-speed controls. A data center is considered big if it has a peak load over 166 tons (583 kW) or if it is over 50 tons (175 kW) and is in a large building that already has a chilled-water plant in the baseline model.

The term "computer rooms" is used in this proposal instead of "data centers" because proposed addendum bu uses this term and includes a definition of computer rooms.

While there is little if any evidence that humidification improves data center reliability, humidification is still common in data centers. Therefore it is treated as a pass-through—i.e., there is no credit for omitting it, but there is no penalty for including it.

Notes were added to Table G3.1.1B to allow multiple heating energy sources for new baseline System 9.

The consensus on a reasonable baseline for economizers is that CRAC units serving smaller data centers should not have economizers but that chilled-water plants serving large data centers should include water-side economizers.

System 9 represents VAV CRAH units and other VAV single-zone chilled-water units. Such units typically have considerably lower total static than multizone VAV systems, which typically have terminal units and longer duct runs. The new fan power for System 9 is based on a CRAH fan selection of 2.4 in. wc (598 Pa) total pressure and 60% fan efficiency.

The randomized computer room equipment schedule is intended to capture part-load system performance in the proposed and base case models. While it is not realistic to have computer room loads vary drastically month to month, it is common for loads to vary gradually over months or years. The schedule proposed here captures this effect in a single annual simulation. It also allows the various load conditions to be simulated under the various weather conditions.

The System 9 supply air temperature and fan control sequence is common for variable-speed CRAH units.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cj to Standard 90.1-2010

Modify Section G3 as follows (I-P and SI units).

G3.1.1 Baseline HVAC System Type and Description. HVAC systems in the *baseline building design* shall be based on usage, number of floors, conditioned floor area, and heating source as specified in Table G3.1.1A and shall conform with the system descriptions in Table G3.1.1B. For systems 1, 2, 3, ~~and~~ 4 and 11, each thermal block shall be modeled with its own HVAC system. For systems 5, 6, 7, and 8, each floor shall be modeled with a separate HVAC system. Floors with identical thermal blocks can be grouped for modeling purposes.

Exceptions to G3.1.1:

a. Use additional system type(s) for non-predominant conditions (i.e., residential/nonresidential or heating source) if those conditions apply to more than 20,000 ft^2 (1900 m^2) of conditioned floor area.

b. If the baseline HVAC system type is 5, 6, 7, or 8, use separate single-zone systems conforming with the requirements of System 3 or System 4 (depending on building heating source) for any spaces that have occupancy or process loads or schedules that differ significantly from the rest of the building. Peak thermal loads that differ by 10 $Btu/h \cdot ft^2$ or more from the average of other spaces served by the system or schedules that differ by more than 40 equivalent full load hours per week from other spaces served by the system are considered to differ significantly. Examples where this exception may be applicable include, but are not limited to, ~~computer server rooms,~~ natatoriums and continually occupied security areas. This exception does not apply to computer rooms.

c. If the baseline HVAC system type is 5, 6, 7, or 8, use separate single-zone systems conforming with the requirements of System 3 or System 4 (depending on building heat source) for any zones having special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates.

d. For laboratory spaces with a minimum of 5000 cfm of exhaust, use system type 5 or 7 that reduce the exhaust and makeup air volume to 50% of design values during unoccupied periods. For all-electric buildings, the heating shall be electric resistance.

[. . .]

g. Computer rooms in buildings with a total computer room peak cooling load >3,000,000 Btu/h (590 kW) or a total computer room peak cooling load >600,000 Btu/h (175 kW) where the baseline HVAC system type is 7 or 8 shall use System 11. All other computer rooms shall use System 3 or 4.

Modify Table G3.1 as follows (I-P and SI units). Changes are shown relative to addendum r to Standard 90.1-2007.

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
4.	**Schedules**	
	Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation shall be used. The schedules shall be typical of the proposed building type as determined by the designer and approved by the rating authority. **HVAC Fan Schedules**. Schedules for HVAC fans that provide outdoor air for ventilation shall run continuously whenever spaces are occupied and shall be cycled on and off to meet heating and cooling loads during unoccupied hours. Exceptions: a. Where no heating and/or cooling system is to be installed and a heating or cooling system is being simulated only to meet the requirements described in this table, heating and/or cooling system fans shall not be simulated as running continuously during occupied hours but shall be cycled on and off to meet heating and cooling loads during all hours. b. HVAC fans shall remain on during occupied and unoccupied hours in spaces that have health and safety mandated minimum ventilation requirements during unoccupied hours. <u>c. HVAC fans shall remain on during occupied and unoccupied hours in systems primarily serving computer rooms.</u>	Same as proposed design. **Exception:** Schedules may be allowed to differ between proposed design and baseline building design when necessary to model nonstandard efficiency measures, provided that the revised schedules have the approval of the rating authority. Measures that may warrant use of different schedules include, but are not limited to, automatic lighting controls, automatic natural ventilation controls, automatic demand control ventilation controls, and automatic controls that reduce service water heating loads. In no case shall schedules differ where the controls are manual (e.g. manual operation of light switches or manual operation of windows).
10.	**HVAC Systems**	
	The HVAC system type and all related performance parameters in the proposed design, such as equipment capacities and efficiencies, shall be determined as follows: a. Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. b. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. c. Where no heating system exists or no heating system has been specified, the heating system classification shall be assumed to be electric, and the system characteristics shall be identical to the system modeled in the baseline building design. d. Where no cooling system exists or no cooling system has been specified, the cooling system shall be identical to the system modeled in the baseline building design.	The HVAC system(s) in the baseline building design shall be of the type and description specified in G3.1.1, shall meet the general HVAC system requirements specified in G3.1.2, and shall meet any system-specific requirements in G3.1.3 that are applicable to the baseline HVAC system type(s). <u>If the proposed design includes computer room humidification then the computer room humidification system, schedules, and setpoints in the baseline building design shall be the same as in the proposed design.</u> <u>For systems serving computer rooms, the baseline shall not have reheat for the purpose of dehumidification.</u>

Modify Table G3.1.1B as follows (I-P and SI units).

TABLE G3.1.1B Baseline System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type
1. PTAC	Packaged terminal air conditioner	Constant volume	Direct expansion	Hot-water fossil fuel boiler
2. PTHP	Packaged terminal heat pump	Constant volume	Direct expansion	Electric heat pump
3. PSZ-AC	Packaged rooftop air conditioner	Constant volume	Direct expansion	Fossil fuel furnace
4. PSZ-HP	Packaged rooftop heat pump	Constant volume	Direct expansion	Electric heat pump
5. Packaged VAV with reheat	Packaged rooftop VAV with reheat	VAV	Direct expansion	Hot-water fossil fuel boiler
6. Packaged VAV with PFP boxes	Packaged rooftop VAV with reheat	VAV	Direct expansion	Electric resistance
7. VAV with reheat	VAV with reheat	VAV	Chilled water	Hot-water fossil fuel boiler
8. VAV with PFP Boxes	VAV with parallel fan-powered boxes and reheat	VAV	Chilled water	Electric resistance
9. Heating and Ventilation	Warm air furnace, gas fired	Constant volume	None	Fossil fuel furnace
10. Heating and Ventilation	Warm air furnace, electric	Constant volume	None	Electric resistance
11. SZ–VAV	Single-zone VAV	VAV	Chilled water	See note.

Note: Where the proposed design heating source is electric or other, the heating type shall be electric resistance. Where the proposed design heating source is fossil fuel, fossil/electric hybrid, or purchased heat, the heating type shall be hot-water fossil fuel boiler.

Modify Section G3 as follows (I-P and SI units).

G3.1.2.7 Economizers. Outdoor air economizers shall not be included in baseline HVAC Systems 1 and 2. Outdoor air economizers shall be included in baseline HVAC Systems 3 through 8 and 11 based on climate as specified in Table G3.1.2.6A.

Exceptions to G3.1.2.~~6~~7: Economizers shall not be included for systems meeting one or more of the exceptions listed below.

a. Systems that include gas-phase air cleaning to meet the requirements of Section 6.1.2 of ANSI/ASHRAE Standard 62.1. This exception shall be used only if the system in the proposed design does not match the building design.

b. Where the use of outdoor air for cooling will affect supermarket open refrigerated casework systems. This exception shall only be used if the system in the proposed design does not use an economizer. If the exception is used, an economizer shall not be included in the baseline building design.

c. Systems that serve computer rooms complying with Section G3.1.2.7.1.

G3.1.2.7.1 Computer Room Economizers. Systems that serve computer rooms that are HVAC System 3 or 4 shall not have an economizer. Systems that serve computer rooms that are HVAC System 11 shall include an integrated water-side economizer meeting the requirements of Section 6.5.1.2 in the baseline building design. If the simulation software cannot model an integrated water-side economizer, then an air-side economizer shall be modeled.

Modify Table G3.1.2.9 as follows (I-P and SI units).

TABLE G3.1.2.9 Baseline Fan Brake Horsepower

Constant Volume Systems 3–4	Variable Volume Systems 5–8	Variable Volume System 11
$CFM_s \times 0.00094 + A$ ($L_s \times 0.0014 + A$)	$CFM_s \times 0.0013 + A$ ($L_s \times 0.0021 + A$)	$CFM_s \times 0.00062 + A$ ($L_s \times 0.001 + A$)

Where A is calculated according to Section 6.5.3.1.1 using the pressure drop adjustment from the proposed building design and the design flow rate of the baseline building system.

Do not include pressure drop adjustments for evaporative coolers or heat recovery devices that are not required in the baseline building system by Section G3.1.2.10.

Modify Section G3 as follows (I-P and SI units).

G3.1.3.6 Piping Losses (Systems 1, 5, 7~~, and~~ 8, and 11). Piping losses shall not be modeled in either the proposed or baseline building designs for hot water, chilled water, or steam piping.

G3.1.3.7 Type and Number of Chillers (Systems 7~~, and~~ 8, and 11). Electric chillers shall be used in the baseline building design regardless of the cooling energy source, e.g., direct-fired absorption, absorption from purchased steam, or purchased chilled water. The baseline building design's chiller plant shall be modeled with chillers having the number and type as indicated in Table G3.1.3.7 as a function of building peak cooling load.

G3.1.3.8 Chilled-Water Design Supply Temperature (Systems 7~~, and~~ 8, and 11). Chilled-water design supply temperature shall be modeled at 44°F and return water temperature at 56°F.

G3.1.3.9 Chilled-Water Supply Temperature Reset (Systems 7~~, and~~ 8, and 11). Chilled water supply temperature shall be reset based on outdoor dry-bulb temperature using the following schedule: 44°F (6.7°C) at 80°F (27°C) and above, 54°F at 60°F (12°C at 16°C) and below, and ramped linearly between 44°F and 54°F (6.7°C and 12°C)at temperatures between 80°F and 60°F (27°C and 16°C).

Exception: If the baseline chilled-water system serves a computer room HVAC system, the supply chilled-water temperature shall be reset higher based on the HVAC system requiring the most cooling; i.e., the chilled-water setpoint is reset higher until one cooling-coil valve is nearly wide open. The maximum reset chilled-water supply temperature shall be 54°F (12°C).

G3.1.3.10 Chilled-Water Pumps (Systems 7~~, and~~ 8, and 11). The baseline building design pump power shall be 22 W/gpm (349 kW/1000 L/s). Chilled-water systems with a cooling capacity of 300 tons (1055 kW) or more shall be modeled as primary/secondary systems with variable-speed drives on the secondary pumping loop. Chilled-water pumps in systems serving less than 300 tons (1055 kW) cooling capacity shall be modeled as a primary/secondary systems with secondary pump riding the pump curve. For computer room systems using System 11 with an integrated water-side economizer, the baseline building design primary chilled-water pump power shall be increased 5 W/gpm (80 kW/1000 L/s) for flow associated with the water-side economizer.

G3.1.3.11 Heat Rejection (Systems 7~~, and~~ 8, and 11). The heat rejection device shall be an axial fan cooling tower with two-speed fans. Condenser water design supply temperature shall be 85°F or 10°F (29°C or 5.6°C) approach to design wet-bulb temperature, whichever is lower, with a design temperature rise of 10°F(5.6°C). The tower shall be controlled to maintain a 70°F (21°C) leaving water temperature where weather permits, floating up to leaving water temperature at design conditions. The baseline building design condenser water pump power shall be 19 W/gpm(310 kW/1000 L/s). For computer room systems using System 11 with an integrated water-side economizer, the baseline building design condenser water-pump power shall be increased 5 W/gpm (80 kW/1000 L/s) for flow associated with the water-side economizer. Each chiller shall be modeled with separate condenser water and chilled water pumps interlocked to operate with the associated chiller.

[. . .]

G3.1.3.15 VAV Fan Part-Load Performance (Systems 5 through 8 and 11). VAV system supply fans shall have variable-speed drives, and their part-load performance characteristics shall be modeled using either Method 1 or Method 2 specified in Table G3.1.3.15.

G3.1.3.16 Computer Room Equipment Schedules. Computer room equipment schedules shall be modeled as a constant fraction of the peak design load per the following monthly schedule:

Month 1, 5, 9—25%

Month 2, 6, 10—50%

Month 3, 7, 11—75%

Month 4, 8, 12—100%

G3.1.3.17 System 11 Supply Air Temperature and Fan Control. Minimum volume setpoint shall be 50% of the maximum design airflow rate, the minimum ventilation outdoor air flow rate, or the air flow rate required to comply with applicable codes or accreditation standards, whichever is larger.

Fan volume shall be reset from 100% airflow at 100% cooling load to minimum airflow at 50% cooling load. Supply air temperature setpoint shall be reset from minimum supply air temperature at 50% cooling load and above to space temperature at 0% cooling load. In heating mode supply air temperature shall be modulated to maintain space temperature, and fan volume shall be fixed at the minimum airflow.

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

FOREWORD

This addendum requires the use of dual maximum control for VAV zone control when the building has DDC controls.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ck to Standard 90.1-2010

Revise the standard as follows (I-P and SI Units)

6.5.2 Simultaneous Heating and Cooling Limitation

6.5.2.1 Zone Controls. Zone thermostatic controls shall prevent

a. reheating,
b. recooling,
c. mixing or simultaneously supplying air that has been previously mechanically heated and air that has been previously cooled, either by mechanical cooling or by economizer systems, and
d. other simultaneous operation of heating and cooling systems to the same zone.

Exceptions:

a. Zones without DDC for which the volume of air that is reheated, recooled, or mixed is less than the larger of the following:
   1. 30% of the zone design peak supply rate;
   2. The outdoor airflow rate required to meet the ventilation requirements of ~~Section 6.2 of~~ ASHRAE Standard 62.1 for the zone;
   3. Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system.
   4. The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
b. Zones with DDC that comply with all of the following:
   1. The airflow rate in dead band between heating and cooling does not exceed the larger~~r~~st of the following:
      (a) 20% of the zone design peak supply rate;
      (b) The outdoor airflow rate required to meet the ventilation requirements of ~~Section 6.2 of~~ ASHRAE Standard 62.1 for the zone;
      (c) Any higher rate that can be demonstrated, to the satisfaction of the authority having jurisdiction, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in outdoor air intake.
      (d) The airflow rate required to comply with applicable codes or accreditation standards, such as pressure relationships or minimum air change rates.
   2. The airflow rate that is reheated, recooled, or mixed ~~in peak heating demand~~ shall be less than 50% of the zone design peak supply rate.
   ~~3. Airflow between dead band and full heating or full cooling shall be modulated.~~
   3. The first stage of heating consists of modulating the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the dead band flow rate.
   4. The second stage of heating consists of modulating the airflow rate from the dead band flow rate up to the heating maximum flow rate.
c. Laboratory exhaust systems that comply with Section 6.5.7.2.
d. Zones where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered (including condenser heat) or site-solar energy source.

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

FOREWORD

In 2007, ASHRAE approved addenda to ASHRAE/IES Standard 90.1 (addendum s to Standard 90.1-2007), which established for the first time new part-load integrated energy efficiency ratios (IEER) for commercial air-cooled air conditioners and heat pumps greater than 65,000 Btu/h. These new IEER minimums became effective on January 1, 2010. In 2010, ASHRAE approved additional addenda to Standard 90.1 (addendum co to Standard 90.1-2007) that added minimum IEER to water-cooled and evaporatively cooled commercial air conditioners greater than 65,000 Btu/h. These requirements became effective on June 1, 2011.

This proposal updates the IEER values for air-cooled and water-cooled air conditioners and heat pumps above 65,000 Btu/h. Depending on the cooling capacity and product classes, the new IEERs are between 7% and 13% better than the values they replace. The new IEERs will become effective on January 1, 2016.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cl to Standard 90.1-2010

Revise Tables 6.8.1A and 6.8.1B as follows (I-P and SI units).

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (air-cooled)	<65,000 Btu/h[b]	All	Split system	13.0 SEER	AHRI 210/240
			Single package	13.0 SEER	
Through-the-wall (air-cooled)	≤30,000 Btu/h[b]	All	Split system	12.0 SEER	
			Single package	12.0 SEER	
Air conditioners (air-cooled)	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and Single package	11.2 EER 11.4 IEER (before 1/1/2016) 12.9 IEER (as of 1/1/2016)	AHRI 340/360
		All other	Split system and Single package	11.0 EER 11.2 IEER (before 1/1/2016) 12.7 IEER (before 1/1/2016)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and Single package	11.0 EER 11.2 IEER (before 1/1/2016) 12.4 IEER (as of 1/1/2016)	
		All other	Split system and Single package	10.8 EER 11.0 IEER (before 1/1/2016) 12.2 IEER (as of 1/1/2016)	
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split system and Single package	10.0 EER 10.1 IEER (before 1/1/2016) 11.6 IEER (as of 1/1/2016)	
		All other	Split system and Single package	9.8 EER 9.9 IEER (before 1/1/2016) 11.4 IEER (as of 1/1/2016)	
	≥760,000 Btu/h	Electric resistance (or none)	Split system and Single package	9.7 EER 9.8 IEER (before 1/1/2016) 11.2 IEER (as of 1/1/2016)	
		All other	Split system and Single package	9.5 EER 9.6 IEER (before 1/1/2016) 11.0 IEER (as of 1/1/2016)	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (I-P) *(continued)*

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (water-cooled)	<65,000 Btu/h	All	Split system and Single package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.5 EER (before 6/1/2011)~~ 12.1 EER ~~(as of 6/1/2011)~~ ~~11.7 IEER (before 6/1/2011)~~ 12.3 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.9 IEER (as of 1/1/2016)	AHRI 340/360
		All other	Split system and Single package	~~11.3 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~ ~~11.5 IEER (before 6/1/2011)~~ 12.1 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.7 IEER (as of 1/1/2016)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 12.5 EER ~~(as of 6/1/2011)~~ ~~11.2 IEER (before 6/1/2011)~~ 12.5 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.9 IEER (as of 1/1/2016)	
		All other	Split system and Single package	~~10.8 EER (before 6/1/2011)~~ 12.3 EER ~~(as of 6/1/2011)~~ ~~11.0 IEER (before 6/1/2011)~~ 12.5 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.7 IEER (as of 1/1/2016)	
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 12.4 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 12.6 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.6 IEER (as of 1/1/2016)	
		All other	Split system and Single package	~~10.8 EER (before 6/1/2011)~~ 12.2 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 12.4 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.4 IEER (as of 1/1/2016))	
	≥760,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 12.2 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 12.4 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.5 IEER (as of 1/1/2016)	AHRI 340/360
		All other	Split System and Single Package	~~10.8 EER (before 6/1/2011)~~ 12.0 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 12.2 IEER (~~as of 6/1/2011~~ before 1/1/2016) 13.3 IEER (as of 1/1/2016)	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (I-P) ***(continued)***

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
	<65,000 Btu/h[b]	All	Split system and Single package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and single package	~~11.5 EER (before 6/1/2011)~~ 12.1 EER ~~(as of 6/1/2011)~~ ~~11.7 IEER (before 6/1/2011)~~ 12.3 IEER ~~(as of 6/1/2011)~~	
		All other	Split system and Single package	~~11.3 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~ ~~11.5 IEER (before 6/1/2011)~~ 12.1 IEER ~~(as of 6/1/2011)~~	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 12.0 EER ~~(as of 6/1/2011)~~ ~~11.2 IEER (before 6/1/2011)~~ 12.2 IEER ~~(as of 6/1/2011)~~	
Air conditioners (evaporatively cooled)		All other	Split system and Single package	~~10.8 EER (before 6/1/2011)~~ 11.8 EER ~~(as of 6/1/2011)~~ ~~11.0 IEER (before 6/1/2011)~~ 12.0 IEER ~~(as of 6/1/2011)~~	AHRI 340/360
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 11.9 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 12.1 IEER ~~(as of 6/1/2011)~~	
		All other	Split system and Single package	~~10.8 EER (before 6/1/2011)~~ 11.7 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 11.9 IEER ~~(as of 6/1/2011)~~	
	≥760,000 Btu/h	Electric resistance (or none)	Split system and Single package	~~11.0 EER (before 6/1/2011)~~ 11.7 EER ~~(as of 6/1/2011)~~ ~~11.1 IEER (before 6/1/2011)~~ 11.9 IEER ~~(as of 6/1/2011)~~	
		All other	Split system and Single package	~~10.8 EER (before 6/1/2011)~~ 11.5 EER ~~(as of 6/1/2011)~~ ~~10.9 IEER (before 6/1/2011)~~ 11.7 IEER ~~(as of 6/1/2011)~~	
Condensing units (air-cooled)	≥135,000Btu/h			~~10.1 EER (before 6/1/2011)~~ 10.5 EER ~~(as of 6/1/2011)~~ ~~11.4 IEER (before 6/1/2011)~~ 11.8 IEER ~~(as of 6/1/2011)~~	
Condensing units (water-cooled)	≥135,000Btu/h			~~13.1 EER (before 6/1/2011)~~ 13.5 EER ~~(as of 6/1/2011)~~ ~~13.6 IEER (before 6/1/2011)~~ 14.0 IEER ~~(as of 6/1/2011)~~	AHRI 365
Condensing units (evaporatively cooled)	≥135,000Btu/h			~~13.1 EER (before 6/1/2011)~~ 13.5 EER ~~(as of 6/1/2011)~~ ~~13.6 IEER (before 6/1/2011)~~ 14.0 IEER ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <65,000 Btu/hr are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air-cooled (cooling mode)	<65,000 Btu/h[b]	All	Split system	13.0 SEER	AHRI 210/240
			Single package	13.0 SEER	
Through-the-wall (air-cooled)	≤30,000 Btu/h[b]	All	Split system	12.0 SEER	
			Single package	12.0 SEER	
Air-cooled (cooling mode)	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and Single package	11.0 EER 11.2 IEER <u>(before 1/1/2016)</u> <u>12.2 IEER (as of 1/1/2016)</u>	AHRI 340/360
		All other	Split system and Single package	10.8 EER 11.0 IEER <u>(before 1/1/2016)</u> <u>12.0 IEER (as of 1/1/2016)</u>	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and Single package	10.6 EER 10.7 IEER <u>(before 1/1/2016)</u> <u>11.6 IEER (as of 1/1/2016)</u>	
		All other	Split system and Single package	10.4 EER 10.5 IEER <u>(before 1/1/2016)</u> <u>11.4 IEER (as of 1/1/2016)</u>	
	≥240,000 Btu/h	Electric resistance (or none)	Split system and Single package	9.5 EER 9.6 IEER <u>(before 1/1/2016)</u> <u>10.6 IEER (as of 1/1/2016)</u>	
		All other	Split system and Single package	9.3 EER 9.4 IEER <u>(before 1/1/2016)</u> <u>10.4 IEER (as of 1/1/2016)</u>	
Water-to-air, water loop (cooling mode)	<17,000 Btu/h	All	86°F entering water	12.2 EER	ISO 13256-1
	≥17,000 Btu/h and <65,000 Btu/h	All	86°F entering water	13 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	86°F entering water	13 EER	
Water-to-air, ground water (cooling mode)	<135,000 Btu/h	All	59°F entering water	18.0 EER	
Brine-to-air, ground loop (cooling mode)	<135,000 Btu/h	All	77°F entering water	14.1 EER	
Water-to-water, water loop (cooling mode)	<135,000 Btu/h	All	86°F entering water	10.6 EER	ISO 13256-2
Water-to-water, ground water (cooling mode)	<135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine-to-water, ground loop (cooling mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements (I-P) *(continued)*

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air-cooled (heating mode)	<65,000 Btu/h[eb]	—	Split system	7.7 HSPF	AHRI 210/240
		—	Single package	7.7 HSPF	
Through-the-wall, air-cooled (heating mode)	≤30,000 Btu/h[b] (cooling capacity)	—	Split system	7.4 HSPF	
		—	Single package	7.4 HSPF	
Air-cooled, (heating mode)	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb outdoor air	3.3 COP	AHRI 340/360
		—	17°F db/15°F wb outdoor air	2.25 COP	
	≥135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb outdoor air	3.2 COP	
		—	17°F db/15°F wb outdoor air	2.05 COP	
Water-to-air, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68°F entering water	4.3 COP	ISO 13256-1
Water-to-air, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50°F entering water	3.7 COP	
Brine-to-air, ground loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.2 COP	
Water-to-water, water loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	ISO 13256-2
Water-to-water, ground water (heating mode)	<135,000 Btu/h (cooling capacity)	—	50°F entering water	3.1 COP	
Brine-to-water, ground loop (heating mode)	<135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (air-cooled)	<19 kW[b]	All	Split system	3.81 $SCOP_C$	AHRI 210/240
			Single package	3.81 $SCOP_C$	
Through-the-wall (air-cooled)	≤9 kW[b]	All	Split system	3.51 $SCOP_C$	
			Single package	3.51 $SCOP_C$	
Air conditioners (air-cooled)	≥19 kW and <40 kW	Electric resistance (or none)	Split system and Single package	3.28 COP_C 3.34 $ICOP_C$ (before 1/1/2016) 3.78 $ICOP_C$ (as of 1/1/2016)	AHRI 340/360
		All other	Split system and Single package	3.22 COP_C 3.28 $ICOP_C$ (before 1/1/2016) 3.72 $ICOP_C$ (before 1/1/2016)	
	≥40 kW and <70 kW	Electric resistance (or none)	Split system and Single package	3.22 COP_C 3.28 $ICOP_C$ (before 1/1/2016) 3.63 $ICOP_C$ (as of 1/1/2016)	
		All other	Split system and Single package	3.17 COP_C 3.22 $ICOP_C$ (before 1/1/2016) 3.58 $ICOP_C$ (as of 1/1/2016)	
	≥70 kW and <223 kW	Electric resistance (or none)	Split system and Single package	2.93 COP_C 2.96 $ICOP_C$ (before 1/1/2016) 3.40 $ICOP_C$ (as of 1/1/2016)	
		All other	Split system and Single package	2.87 COP_C 2.90 $ICOP_C$ (before 1/1/2016) 3.34 $ICOP_C$ (as of 1/1/2016)	
	≥223 kWk	Electric resistance (or none)	Split system and Single package	2.84 COP_C 2.87 $ICOP_C$ (before 1/1/2016) 3.28 $ICOP_C$ (as of 1/1/2016)	
		All other	Split system and Single package	2.78 COP_C 2.81 $ICOP_C$ (before 1/1/2016) 3.22 $ICOP_C$ (as of 1/1/2016)	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (SI) ***(continued)***

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (water-cooled)	<19 kW	All	Split system and single package	3.55 COP$_C$ 3.60 ICOP$_C$	AHRI 210/240
	≥19 kW and <40 kW	Electric resistance (or none)	Split system and single package	3.55 COP$_C$ 3.60 ICOP$_C$ before 1/1/2016) 4.07 ICOP$_C$ (as of 1/1/2016)	AHRI 340/360
		All other	Split system and single package	3.49 COP$_C$ 3.55 ICOP$_C$ before 1/1/2016) 4.02 ICOP$_C$ (as of 1/1/2016)	
	≥40 kW and <70 kW	Electric resistance (or none)	Split system and single package	3.66 COP$_C$ 3.66 ICOP$_C$ before 1/1/2016) 4.07 ICOP$_C$ (as of 1/1/2016)	
		All other	Split system and single package	3.60 COP$_C$ 3.66 ICOP$_C$ before 1/1/2016) 4.02 ICOP$_C$ (as of 1/1/2016)	
	≥70 kW and <223 kW	Electric resistance (or none)	Split system and single package	3.63 COP$_C$ 3.69 ICOP$_C$ before 1/1/2016) 3.99 ICOP$_C$ (as of 1/1/2016)	
		All other	Split system and single package	3.58 COP$_C$ 3.63 ICOP$_C$ before 1/1/2016) 3.93 ICOP$_C$ (as of 1/1/2016)	
Air conditioners (water-cooled)	≥223 kW	Electric resistance (or none)	Split system and single package	~~3.22 COP$_C$ (before 6/1/2011)~~ 3.58 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.63 ICOP$_C$ (~~as of 6/1/2011~~ before 1/1/2016) 3.96 ICOP$_C$ (as of 1/1/2016)	AHRI 340/360
		All other	Split system and single package	~~3.17 COP*C* (before 6/1/2011)~~ 3.52 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.58 ICOP$_C$ (~~as of 6/1/2011~~ before 1/1/2016) 3.90 ICOP$_C$ (as of 1/1/2016)	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units— Minimum Efficiency Requirements (SI) *(continued)*

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air conditioners (evaporatively cooled)	<19 kW[b]	All	Split system and single package	3.55 COP$_C$ 3.60 ICOP$_{\underline{C}}$	AHRI 210/240
	≥19 kW and <40 kW	Electric resistance (or none)	Split system and single package	~~3.37 COP$_C$ (before 6/1/2011)~~ 3.55 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.43 ICOP (before 6/1/2011)~~ 3.60 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	AHRI 340/360
		All other	Split system and single package	~~3.31 COP$_C$ (before 6/1/2011)~~ 3.49 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.37 ICOP (before 6/1/2011)~~ 3.55 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
	≥40 kW and <70 kW	Electric resistance (or none)	Split system and single package	~~3.22 COP$_C$ (before 6/1/2011)~~ 3.52 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.28 ICOP (before 6/1/2011)~~ 3.58 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
		All other	Split system and single package	~~3.17 COP$_C$ (before 6/1/2011)~~ 3.46 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.22 ICOP (before 6/1/2011)~~ 3.52 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
	≥70 kW and <223 kW	Electric resistance (or none)	Split system and single package	~~3.22 COP$_C$ (before 6/1/2011)~~ 3.49 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.55 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
		All other	Split system and single package	~~3.17 COPC (before 6/1/2011)~~ 3.43 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.49 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
	≥223 kW	Electric resistance (or none)	Split system and single package	~~3.22 COP$_C$ (before 6/1/2011)~~ 3.43 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.25 ICOP (before 6/1/2011)~~ 3.49 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
		All other	Split system and single package	~~3.17 COP$_C$ (before 6/1/2011)~~ 3.37 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.19 ICOP (before 6/1/2011)~~ 3.43 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
Condensing units (air-cooled)	≥40 kW			~~2.96 COP$_C$ (before 6/1/2011)~~ 3.08 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.34 ICOP (before 6/1/2011)~~ 3.46 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	AHRI 365
Condensing units (water-cooled)	≥40 kW			~~3.84 COP$_C$ (before 6/1/2011)~~ 3.96 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.99 ICOP (before 6/1/2011)~~ 4.10 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	
Condensing units (evaporatively cooled)	≥40 kW			~~3.84 COP$_C$ (before 6/1/2011)~~ 3.96 COP$_C$ ~~(as of 6/1/2011)~~ ~~3.99 ICOP (before 6/1/2011)~~ 4.10 ICOP$_{\underline{C}}$ ~~(as of 6/1/2011)~~	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps— Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air-cooled (cooling mode)	<19 kW[b]	All	Split system	3.81 SCOP$_C$	AHRI 210/240
			Single package	3.81 SCOP$_C$	
Through-the-wall (air-cooled)	≤9 kW[b]	All	Split system	3.52 SCOP$_C$	
			Single package	3.52 SCOP$_C$	
Air-cooled (cooling mode)	≥19 kW and <40 kW	Electric resistance (or none)	Split system and single package	3.22 COP$_C$ 3.28 ICOP$_C$ (before 1/1/2016) 3.57 ICOP$_C$ (as of 1/1/2016)	AHRI 340/360
		All other	Split system and single package	3.17 COP$_C$ 3.22 ICOP$_C$ (before 1/1/2016) 3.52 ICOP$_C$ (as of 1/1/2016)	
	≥40 kW and <70 kW	Electric resistance (or none)	Split system and single package	3.11 COP$_C$ 3.14 ICOP$_C$ (before 1/1/2016) 3.40 ICOP$_C$ (as of 1/1/2016)	
		All other	Split system and single package	3.05 COP$_C$ 3.08 ICOP$_C$ (before 1/1/2016) 3.34 ICOP$_C$ (as of 1/1/2016)	
	≥70 kW	Electric resistance (or none)	Split system and single package	2.78 COP$_C$ 2.81 ICOP$_C$ (before 1/1/2016) 3.11 ICOP$_C$ (as of 1/1/2016)	
		All other	Split system and single package	2.73 COP$_C$ 2.75 ICOP$_C$ (before 1/1/2016) 3.05 ICOP$_C$ (as of 1/1/2016)	
Water-to-air, water loop (cooling mode)	<5 kW	All	30°C entering water	3.58 COP$_C$	ISO 13256-1
	≥5 kW and <19 kW	All	30°C entering water	3.81 COP$_C$	
	≥19 kW and <40 kW	All	30°C entering water	3.81 COP$_C$	
Water-to-air, ground water (cooling mode)	<40 kW	All	15°C entering water	5.28 COP$_C$	
Brine-to-air, ground loop (cooling mode)	<40 kW	All	25°C entering water	4.13 COP$_C$	
Water-to-water, water loop (cooling mode)	<40 kW	All	30°C entering water	3.11 COP$_C$	ISO-13256-2
Water-to-water, ground water (cooling mode)	<40 kW	All	15°C entering water	4.78 COP$_C$	
Brine-to-water, ground loop (cooling mode)	<40 kW	All	25°C entering water	3.55 COP$_C$	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

TABLE 6.8.1B Electrically Operated Unitary and Applied Heat Pumps—Minimum Efficiency Requirements (SI) *(continued)*

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
Air-cooled (heating mode)	<19 kW[b]	—	Split system	2.26 $SCOP_H$	AHRI 210/240
			Single package	2.26 $SCOP_H$	
Through-the-wall, air-cooled (heating mode)	≤9 kW[b] (cooling capacity)	—	Splitsystem	2.17 $SCOP_H$	
			Single package	2.17 $SCOP_H$	
Air-cooled (heating mode)	≥19 kW and <40 kW (Cooling Capacity)	—	8.3°C db/6.1°C wb outdoor air	3.3 COP_H	AHRI 340/360
			–8.3°C db/–9.4°C wb outdoor air	2.25 COP_H	
	≥40 kW (Cooling Capacity)	—	8.3°C db/6.1°C wb outdoor air	3.2 COP_H	
			–8.3°C db/–9.4°C wb outdoor air	2.05 COP_H	
Water-to-air, water loop (heating mode)	<40 kW (cooling capacity)	—	20°C entering water	4.3 COP_H	ISO 13256-1
Water-to-air, ground water (heating mode)	<40 kW (cooling capacity)	—	10°C entering water	3.7 COP_H	
Brine-to-air, ground loop (heating mode)	<40 kW (cooling capacity)	—	0°C entering fluid	3.2 COP_H	
Water-to-water, water loop (heating mode)	<40 kW (cooling capacity)	—	20°C entering water	3.7 COP_H	ISO 13256-2
Water-to-water, ground water (heating mode)	<40 kW (cooling capacity)	—	10°C entering water	3.1 COP_H	
Brine-to-water, ground loop (heating mode)	<40 kW (cooling capacity)	—	0°C entering fluid	2.5 COP_H	

a. Section 12 contains a complete specification of the referenced test procedure, including the reference year version of the test procedure
b. Single phase, air cooled air conditioners <19 kW are regulated by NAECA, SEER values are those set by NAECA

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

FOREWORD

The text clarifies how to interpret the use of dynamic glazing products which are designed to be able to vary a performance property such as SHGC and VT, rather than having just a single value. As the ratings for these products give a range of performance values, designers and code officials require an interpretation on what to use for compliance with the standard.

This addendum shows modifications to language in addendum "bb."

Informative Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cm to Standard 90.1-2007

Revise the standard as follows (I-P and SI units).

5.5.4.1 General. Compliance with U-factors, ~~and~~ SHGC and VT / SHGC shall be demonstrated for the overall fenestration product. Gross wall areas and gross roof areas shall be calculated separately for each space-conditioning category for the purposes of determining compliance.

Exceptions: If there are multiple assemblies within a single class of construction for a single space-conditioning category, compliance shall be based on an area-weighted average U-factor, ~~or~~ SHGC, VT / SHGC, or LSG. It is not acceptable to do an area-weighted average across multiple classes of construction or multiple space-conditioning categories.

Add new exception to Section 5.5.4.5, "Visible Transmittance/SHGC Ratio" of addendum "bb."

6. For dynamic glazing, the VT/SHGC ratio and the LSG shall be determined using the maximum VT and maximum SHGC. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.

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FOREWORD

The purpose of this addendum is to allow laboratory designs that incorporate strategies to reduce peak airflows and minimum unoccupied airflows to document energy savings associated with reduced outdoor air volumes.

Laboratory systems are often required by the rating authority or accreditation standards to be 100% outdoor air. Currently, the standard requires ventilation rates for the baseline design to be the same as for the proposed design. Rating authorities interpret this to mean that in the case where baseline airflow is greater than in the proposed design, the baseline system is to be modeled as a recirculating air system. In order to provide credit to proposed design systems that have lower peak design airflow, the baseline is allowed to vary from the proposed.

In addition, the current standard requires baseline minimum airflows in laboratory spaces to be the largest of 50% of zone peak airflow, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards. Where owners install systems and controls that reduce laboratory airflows below these minimum thresholds, the baseline is required to be modeled as a recirculating system, and the proposed design is not credited with savings associated with reduced outdoor air conditioning.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cn to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

G3.1.2.6 Ventilation. Minimum ventilation system outdoor air intake flow shall be the same for the proposed and baseline building designs.

Exceptions:

<u>d. For baseline systems serving only laboratory spaces that are prohibited from recirculating return air by code or accreditation standards, the baseline system shall be modeled as 100% outdoor air.</u>

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FOREWORD

Table 9.5.1 has been modified for the following purpose: LPDs have been adjusted to account for changes to recommended light levels as published in the new, 10th Edition of the IES Lighting Handbook. Some values have increased while others decreased. An expanded data set with 56% additional representative buildings was used to develop the building area LPDs. As an average, the changed LPDs dropped 5%.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum co to Standard 90.1-2010

Revise Table 9.5.1 as follows (I-P and SI units).

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method (I-P)

Building Area Type[a]	*LPD*, (W/ft^2)
Automotive facility	~~0.82~~0.80
Convention center	~~1.08~~1.01
Courthouse	~~1.05~~1.01
Dining: bar lounge/leisure	~~0.99~~1.01
Dining: cafeteria/fast food	~~0.90~~0.90
Dining: family	~~0.89~~0.95
Dormitory	~~0.61~~0.57
Exercise center	~~0.88~~0.84
Fire station	~~0.71~~0.67
Gymnasium	~~1.00~~0.94
Health-care clinic	~~0.87~~0.90
Hospital	~~1.21~~1.05
Hotel/Motel	~~1.00~~0.87
Library	~~1.18~~1.19
Manufacturing facility	~~1.11~~1.17
~~Motel~~	~~0.88~~
Motion picture theater	~~0.83~~0.76
Multifamily	~~0.60~~0.51
Museum	~~1.06~~1.02
Office	~~0.90~~0.82
Parking garage	~~0.25~~0.21
Penitentiary	~~0.97~~0.81
Performing arts theater	~~1.39~~1.39
Police station	~~0.96~~0.87
Post office	~~0.87~~0.87
Religious building	~~1.05~~1.00
Retail	~~1.40~~1.26
School/university	~~0.99~~0.87
Sports arena	~~0.78~~0.91
Town hall	~~0.92~~0.89
Transportation	~~0.77~~0.70
Warehouse	~~0.66~~0.66
Workshop	~~1.20~~1.19

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method (SI)

Building Area Type[a]	LPD, (W/m^2)
Automotive facility	~~8.8~~8.6
Convention center	~~11.6~~10.9
Courthouse	~~11.3~~10.9
Dining: bar lounge/leisure	~~10.7~~10.9
Dining: cafeteria/fast food	~~9.7~~9.7
Dining: family	~~9.6~~10.2
Dormitory	~~6.6~~6.1
Exercise center	~~9.5~~9.0
Fire station	~~7.6~~7.2
Gymnasium	~~10.8~~10.1
Health-care clinic	~~9.4~~9.7
Hospital	~~13.0~~11.3
Hotel/Motel	~~10.8~~9.4
Library	~~12.7~~12.8
Manufacturing facility	~~11.9~~12.6
~~Motel~~	~~9.5~~
Motion picture theater	~~8.9~~8.2
Multifamily	~~6.5~~5.5
Museum	~~11.4~~11.0
Office	~~9.7~~8.8
Parking garage	~~2.7~~2.3
Penitentiary	~~10.4~~8.7
Performing arts theater	~~15.0~~15.0
Police station	~~10.3~~9.4
Post office	~~9.4~~9.4
Religious building	~~11.3~~10.8
Retail	~~15.1~~13.6
School/university	~~10.7~~9.4
Sports arena	~~8.4~~9.8
Town hall	~~9.9~~9.6
Transportation	~~8.3~~7.5
Warehouse	~~7.1~~7.1
Workshop	~~12.9~~12.8

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

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FOREWORD

This revision corrects a value in Table 5.5-3 for steel joist floors that was not correctly edited when the four public review drafts of Addendum bb were being processed.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cp to Standard 90.1-2010

Revise the standard as follows (I-P and SI units, respectively).

TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A,B,C)* (IP)

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value
[. . .]						
Floors						
Mass	U-0.074	R-10 c.i.	U-0.074	R-10 c.i.	U-0.137	R-4.2 c.i.
Steel Joist	~~U-0.052~~ U-0.038	~~R-19~~ R-30	U-0.032	R-38	U-0.052	R-19
Wood-Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
[. . .]						

TABLE 5.5-3 Building Envelope Requirements For Climate Zone 3 (A,B,C)* (SI)

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value
[. . .]						
Floors						
Mass	U-0.420	R-1.8 c.i.	U-0.420	R-1.8 c.i.	U-0.780	R-07 c.i.
Steel Joist	~~U-0.296~~ U-0.214	~~R-3.3~~ R-5.3	U-0.183	R-6.7	U-0.296	R-3.3
Wood-Framed and Other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.288	R-3.3
[. . .]						

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FOREWORD

Table 9.6.1 has been modified for the following purposes:

- *Corrected the required light level for hospital corridors to 30 fc average to address needs for hazmat cleanup. This changes the hospital corridor LPD from 0.79 to 0.99.*
- *Corrected the assisted-living dining space LPD model to the appropriate RP-28 light level of 50 fc, which changes the LPD from 1.90 to 2.65.*
- *Corrected the retail sales space because the previous value was based on an average of six retail space types instead of the original four that are appropriate for the typical retail value. This changes the sales area value from 1.59 to 1.44.*
- *Developed a new LPD to address very small storage spaces where the small LPD allowance is not sufficient to provide minimum lighting equipment. This creates a value of 1.24.*
- *Revised the footnote that identifies what facilities can get the higher assisted-living LPDs to restrict to only those for which it was developed and added a reference.*
- *Modified the assisted-living recreation room space type to include common living rooms.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cr to Standard 90.1-2010

Modify Table 9.6.1 as follows (I-P and SI units).

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method

Common Space Types[1]	LPD, W/ft² (W/m²)	RCR Threshold
Corridor[2]		
… in a hospital	~~0.79~~0.99 (10.7)	width <8 ft
Dining Area		
… in a facility for the visually impaired (and not used primarily by staff)[3]	~~1.90~~ 2.65 (28.5 W/m²)	4
Sales Area[4]	~~1.59~~1.44 (15.5 W/m²)	6
Storage Room		
… that is ≥50 ft²	0.63	6
… that is ≤50 ft²	1.24	6
[. . .]		

Building Type Specific Space Types	LPD, W/ft² (W/m²)	RCR Threshold
Facility for the Visually Impaired [3]		
… in a recreation room/common living room (and not used primarily by staff)	2.41	6
[. . .]		

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft (2.8 m) and is not based on the RCR.
3. A 'Facility for the Visually Impaired' is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
4. ~~An 'Assisted Living Facility' is a facility that is licensed by local/state authorities for either senior care or people with special visual needs and designed to comply with the requirements of ANSI/IES RP-28. An 'Assisted Living Facility' is a residential facility for people with special needs or disabilities that provides help with everyday tasks such as bathing, dressing, and taking medication.~~
5. For accent lighting, see Section 9.6.2b.

Modify Section 12 as follows (I-P and SI units).

Reference	Title
[. . .]	
Illuminating Engineering Society (IES) **120 Wall street, Floor 17, New York, NY 10005-4001**	
ANSI/IES RP-28-2007	Lighting and the Visual Environment for Senior Living
[. . .]	

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FOREWORD

This addendum corrects a mistake that was made when HVAC systems for heated-only storage areas was added to Appendix G. These are single-zone systems and, as such, should be assigned to a single thermal zone instead of being grouped with the multiple-zone systems.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum ct to Standard 90.1-2010

Revise Appendix G as follows (I-P and SI units).

G3.1.1 Baseline HVAC System Type and Description. HVAC systems in the baseline building design shall be based on usage, number of floors, conditioned floor area, and heating source as specified in Table G3.1.1A and shall conform with the system descriptions in Table G3.1.1B. For systems 1, 2, 3, ~~and~~ 4, 9, and 10 each thermal block shall be modeled with its own HVAC system. For systems 5, 6, 7, and 8~~, 9, and 10~~ each floor shall be modeled with a separate HVAC system. Floors with identical thermal blocks can be grouped for modeling purposes.

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

FOREWORD

This addendum develops baseline energy use guidance for public assembly spaces toward assessing energy performance achievement of a proposed building. Public assembly spaces are typically designed and operated quite differently than the surrounding supporting building. This addendum provides a list of the intended public assembly spaces and defines a baseline mechanical system for them.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cv to Standard 90.1-2010

Revise Appendix G as follows (I-P and SI units). Note: Addendum ct further modifies the requirements of Section G3.1.1. Those changes are not shown in this addendum.

G3.1.1 Baseline HVAC System Type and Description. HVAC systems in the *baseline building design* shall be based on usage, number of floors, conditioned floor area, and heating source as specified in Table G3.1.1A and with the system descriptions in Table G3.1.1B. For systems 1, 2, 3, ~~and~~ 4, 11, and 12, each thermal block shall be modeled with its own HVAC system. For systems 5, 6, 7, 8, 9, and 10 each floor shall be modeled with a separate HVAC system. Floors with identical thermal blocks can be grouped for modeling purposes.

Exceptions:

a. Use additional system type(s) for nonpredominant conditions (i.e., residential/nonresidential or heating source) if those conditions apply to more than 20,000 ft^2 (1858 m^2)of conditioned floor area.

b. If the baseline HVAC system type is 5, 6, 7, 8, 9,~~ or~~ 10, 11, or 12 use separate single-zone systems conforming with the requirements of System 3 or System 4 (depending on building heating source) for any spaces that have occupancy or process loads or schedules that differ significantly from the rest of the building. Peak thermal loads that differ by 10 Btu/$h \cdot ft^2$ (0.98 $kJ/h \cdot m^2$) or more from the average of other spaces served by the system or schedules that differ by more than 40 equivalent full-load hours per week from other spaces served by the system are considered to differ significantly. Examples where this exception may be applicable include, but are not limited to, computer server rooms, natatoriums, and continually occupied security areas.

TABLE G3.1.1A Baseline HVAC System Types

Building Type	Fossil Fuel, Fossil/Electric Hybrid, and Purchased Heat	Electric and Other
Residential	System 1—PTAC	System 2—PTHP
Public assembly < 120,000 ft^2 (11.148 m^2)	System 3—PSZ-AC	System 4—PSZ-HP
Public assembly ≥ 120,000 ft^2 (11.148 m^2)	System 3—PSZ-AC	System 12—SZ-CV-ER
Nonresidential and 3 floors or fewer and <25,000 ft^2 (2300 m^2)	System 3—PSZ-AC	System 4—PSZ-HP
Nonresidential and 4 or 5 floors and <25,000 ft^2 (2300 m^2) or 5 floors or fewer and 25,000 ft^2 (2300 m^2) to 150,000 ft^2 (14,000 m^2)	System 5—Packaged VAV with reheat	System 6—Packaged VAV with PFP boxes
Nonresidential and more than 5 floors or >150,000 ft^2 (14,000 m^2)	System 7—VAV with reheat	System 8—VAV with PFP boxes
Heated-only storage	System 9—Heating and ventilation	System 10—Heating and ventilation

Notes:

- Residential building types include dormitory, hotel, motel, and multifamily. Residential space types include guest rooms, living quarters, private living space, and sleeping quarters. Other building and space types are considered nonresidential.
- Where no heating system is to be provided or no heating energy source is specified, use the "Electric and Other" heating source classification.
- Where attributes make a building eligible for more than one baseline system type, use the predominant condition to determine the system type for the entire building except as noted in Exception a to Section G3.1.1.
- For laboratory spaces in a building having a total laboratory exhaust rate greater than 5000 cfm2400 L/s, use a single system of type 5 or 7 serving only those spaces. For all-electric buildings, the heating shall be electric resistance
- Public assembly building types include houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers, and natatoriums.

TABLE G3.1.1B Baseline System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type
1. PTAC	Packaged terminal air conditioner	Constant volume	Direct expansion	Hot-water fossil fuel boiler
2. PTHP	Packaged terminal heat pump	Constant volume	Direct expansion	Electric heat pump
3. PSZ-AC	Packaged rooftop air conditioner	Constant volume	Direct expansion	Fossil fuel furnace
4. PSZ-HP	Packaged rooftop heat pump	Constant volume	Direct expansion	Electric heat pump
5. Packaged VAV with Reheat	Packaged rooftop VAV with reheat	VAV	Direct expansion	Hot-water fossil fuel boiler
6. Packaged VAV with PFP Boxes	Packaged rooftop VAV with parallel fan power boxes and reheat	VAV	Direct expansion	Electric resistance
7. VAV with reheat	Packaged rooftop VAV with reheat	VAV	Chilled water	Hot-water fossil fuel boiler
8. VAV with PFP boxes	VAV with parallel fan-powered boxes and reheat	VAV	Chilled water	Electric resistance
9. Heating and Ventilation	Warm air furnace, gas fired	Constant volume	None	Fossil fuel furnace
10. Heating and Ventilation	Warm air furnace, electric	Constant volume	None	Electric resistance
11. SZ-CV-HW	Single zone	Constant volume	Chilled water	Hot-water fossil fuel boiler
12. SZ-CV-ER	Single zone	Constant volume	Chilled water	Electric resistance

Note:
For purchased chilled water and purchased heat, see Section G3.1.1.3.

[. . .]

G3.1.2.7 Economizers. Outdoor air economizers shall not be included in baseline HVAC Systems 1, 2, 9, and 10. Outdoor air economizers shall be included in baseline HVAC Systems 3 through 8 and 11 and 12 based on climate as specified in Table G3.1.2.6A.

[. . .]

G3.1.2.9.1 Baseline All System Types ~~1 through 8~~Except System Types 9 and 10. System design supply air flow rates for the baseline building design shall be based on a supply-air-to-room-air temperature difference of 20°F (11.1°C) or the minimum outdoor air flow rate, or the air flow rate required to comply with applicable codes or accreditation standards, whichever is greater. If return or relief fans are specified in the proposed design, the baseline building design shall also be modeled with fans serving the same functions and sized for the baseline system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger.

[. . .]

G3.1.2.10 System Fan Power. System fan electrical power for supply, return, exhaust, and relief (excluding power to fan-powered VAV boxes) shall be calculated using the following formulas:

For Systems 1 and 2,

$$P_{fan} = \text{CFMs} \times 0.3 \text{ (I-P)}$$

$$P_{fan} = \text{(cubic meters per second)} \times 1.4158\text{e-4 (SI)}$$

For Systems 3 through 8, and 11 and 12,

$$P_{fan} = \text{bhp} \times 746/\text{Fan Motor Efficiency (I-P)}$$

$$P_{fan} = \text{(watts)/fan motor efficiency (SI)}$$

[. . .]

G3.1.3.3 Hot-Water Supply Temperature (Systems 1, 5, 7 and 11~~7~~). Hot-water design supply temperature shall be modeled as 180°F (82°C) and design return temperature as 130°F (54.4°C).

G3.1.3.4 Hot-Water Supply Temperature Reset (Systems 1, 5, 7 and 11~~7~~). Hot-water supply temperature shall be reset based on outdoor dry-bulb temperature using the following schedule: 180°F(82°C) at 20°F (–6.7°C) and below, 150°F (11.1°C) at 50°F (11.1°C) and above [. . .]

[. . .]

G3.1.3.7 Type and Number of Chillers (Systems 7 ~~and~~, 8, 11, and 12). Electric chillers shall be used in the baseline building design regardless of the cooling energy source, e.g., direct fired absorption or absorption from purchased steam. The baseline building design's chiller plant shall be

TABLE G3.1.2.6A Climate Conditions under which Economizers are Included for Comfort Cooling for Baseline Systems 3 through 8 and 11 and 12

Climate Zone	Conditions
1a, 1b, 2a, 3a, 4a	NR
Others	Economizer Included

NR means that there is no conditioned building floor area for which economizers are included for the type of zone and climate.

modeled with chillers having the number and type as indicated in Table G3.1.3.7 as a function of building peak cooling load.

Exception: Systems using purchased chilled water shall be modeled in accordance with Section G3.1.1.3.

G3.1.3.8 Chilled-Water Design Supply Temperature (Systems 7 ~~and~~, 8, 11, and 12). Chilled-water design supply temperature shall be modeled at 44°F(6.7°C) and return water temperature at 56°F(13.3°C).

G3.1.3.9 Chilled-Water Supply Temperature Reset (Systems 7 ~~and~~, 8, 11 and 12). Chilled-water supply temperature shall be reset based on outdoor dry-bulb temperature using the following schedule: 44°F(6.7°C) at 80°F (26.7°C) and above, 54°F (12.2°C) at 60°F (15.6°C) and below, and ramped linearly between 44°F (6.7°C) and 54°F at temperatures between 80°F(26.7°C) and 60°F(15.6°C).

[. . .]

G3.1.3.11 Heat Rejection (Systems 7 ~~and~~, 8, 11, and 12). The heat rejection device shall be an axial fan cooling tower with two-speed fans, and shall meet the performance requirements of Table 6.8.1G. Condenser water design supply temperature shall be 85°F (29.4°C) or 10°F (5.5°C) approaching design wet-bulb temperature, whichever is lower, with a design temperature rise of 10°F (5.5°C). The tower shall be controlled to maintain a 70°F (21°C)leaving water temperature where weather permits, floating up to leaving water temperature at design conditions. The baseline building design condenser-water pump power shall be 19 W/gpm (1.19 W/[L/s]). Each chiller shall be modeled with separate condenser water and chilled-water pumps interlocked to operate with the associated chiller.

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FOREWORD

This addendum revises the requirements for the use of exhaust air energy recovery as defined in Section 6.5.6.1

In 2012, addendum "bt" to ASHRAE/IES Standard 90.1-2010 was developed to expand the range for the use of exhaust air energy recovery down to 10% ventilation rate. In addition, the requirements were adjusted based on the latest performance and economic analysis, and energy recovery was removed for Climate Zones 3B, 3C, 4B, 4C, and 5B for >70% outdoor air. The justification for the elimination was based on the least restrictive application, which was for buildings with ventilation operated less than full time.

Additional studies have been completed for buildings with continuous ventilation operation (assumed to be ≥8,000 h), and a second table has been developed to cover buildings with the higher ventilation operation, which expands the requirements for the use of energy recovery.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cy to Standard 90.1-2010

Revise Section 6 as follows (I-P and SI units).

6.5.6 Energy Recovery

6.5.6.1 Exhaust Air Energy Recovery. Each fan system shall have an energy recovery system when the system's supply air flow rate exceeds the value listed in Tables 6.5.6.1A and 6.5.6.1B based on the climate zone and percentage of outdoor air flow rate at design conditions. Table 6.5.6.1A shall be used for all ventilation systems that operate less than 8000 hours per year and Table 6.5.6.1B shall be used for all ventilation systems that operate 8000 or more hours per year.

Revise Table 6.5.6.1 as follows (I-P and SI units).

TABLE 6.5.6.1A Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Less than 8000 Hours per Year (I-P)

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate (cfm)							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B,5C	NR	NR	NR	NR	≥26,000	≥12,000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11,000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0
7,8	≥4500	≥4000	≥2500	≥1000	≥0	≥0	≥0	≥0

NR—Not required

TABLE 6.5.6.1B Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Greater than or Equal to 8000 Hours per Year (I-P)

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

NR—Not required

TABLE 6.5.6.1A Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Less than 8000 Hours per Year (SI)

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate (L/s)							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B,5C	NR	NR	NR	NR	≥12,271	≥5663	≥2360	≥1888
6B	≥13,215	≥12,507	≥5191	≥2596	≥2124	≥1652	≥1180	≥708
1A, 2A, 3A, 4A, 5A, 6A	≥12,271	≥7551	≥2596	≥2124	≥1652	≥944	≥472	≥0
7,8	≥2124	≥1888	≥1180	≥472	≥0	≥0	≥0	≥0

NR—Not required

TABLE 6.5.6.1B Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Greater than or Equal to 8000 Hours per Year (SI)

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate (L/s)							
3C	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B, 3B, 4C, 5C	NR	≥9203	≥4248	≥2360	≥1888	≥1416	≥708	>0
1A, 2A, 3A, 4B, 5B	≥1180	≥944	≥472	≥236	>0	>0	>0	>0
4A, 5A, 6A, 6B, 7, 8	>0	>0	>0	>0	>0	>0	>0	>0

NR—Not required

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FOREWORD

Section 303 of the Energy Independence and Security Act of 2007 (EISA 2007) increased the federal minimum efficiency standards for residential-sized ("NAECA covered") boilers. This section increased the minimum AFUE for gas- and oil-fired boilers and established design requirements for certain types of new boilers that are manufactured or imported for use in the United States. All of the efficiency and design requirements took effect for equipment built on or after September 1, 2012.

The revisions to the table and the new footnotes will ensure that ASHRAE/IES Standard 90.1-2013 is consistent with federal law.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum cz to Standard 90.1-2010

Revise Table 6.8.1F as follows (I-P and SI units).

TABLE 6.8.1F Gas- and Oil-Fired Boilers, Minimum Efficiency Requirements

Equipment Type[a]	Subcategory or Rating Condition	Size Category (Input)	~~Minimum Efficiencyb,c~~	Minium Efficiency as of ~~3/2/2010~~ ~~(Date 3 yrs after ASHRAE Board Approval)~~	Efficiency as of 3/2/2020 ~~(Date 13 yrs after ASHRAE Board Approval)~~	Test Procedure
Boilers, hot water	Gas fired	<300,000 Btu/h[f,g] (88 kW[f,g])	~~80% AFUE~~	~~80%~~82% AFUE	~~80%~~82% AFUE	10 CFR Part 430
		≥300,000 Btu/h (88 kW) and ≤2,500,000 Btu/h[d] (733 kW)	~~75% Et~~	80% E_t	80% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a] (733 kW[a])	~~80% Ec~~	82% E_c	82% E_c	
	Oil fired[e]	<300,000 Btu/h[g] (88 kW[g])	~~80% AFUE~~	~~80%~~84% AFUE	~~80%~~84% AFUE	10 CFR Part 430
		≥300,000 Btu/h (88 kW) and ≤2,500,000 Btu/h[d] (733 kW)	~~78% Et~~	82% E_t	82% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a] (733 kW[a])	~~83% Ec~~	84% E_c	84% E_c	
Boilers, steam	Gas fired	<300,000 Btu/h[f] (88 kW[f])	~~75% AFUE~~	~~75%~~80% AFUE	~~75%~~80% AFUE	10 CFR Part 430
	Gas fired—all, except natural draft	≥300,000 Btu/h (88 kW) and ≤2,500,000 Btu/h[d] (733 kW)	~~75% Et~~	79% E_t	79% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a] (733 kW[a])	~~80% Ec~~	79% E_t	79% E_t	
	Gas fired—natural draft	≥300,000 Btu/h (88 kW) and ≤2,500,000 Btu/h[d] (733 kW)	~~75% Et~~	77% E_t	79% E_t	
		>2,500,000 Btu/h[a] (733 kW[a])	~~80% Ec~~	77% E_t	79% E_t	
	Oil fired[e]	<300,000 Btu/h (88 kW)	~~80% AFUE~~	~~80%~~82% AFUE	~~80%~~82% AFUE	10 CFR Part 430
		≥300,000 Btu/h (88 kW) and ≤2,500,000 Btu/h[d] (733 kW)	~~78% Et~~	81% E_t	81% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a] (733 kW[a])	~~83% Ec~~	81% E_t	81% E_t	

a. These requirements apply to boilers with rated input of 8,000,000 Btu/h (2346 kW) or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. E_c = combustion efficiency (100% less flue losses). See reference document for detailed information.
c. E_t = thermal efficiency. See reference document for detailed information.
d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
e. Includes oil-fired (residual).
f. Boilers shall not be equipped with a constant burning pilot light.
g. A boiler not equipped with a tankless domestic water heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

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FOREWORD

This addendum provides two compliance paths for high-speed doors within the mandatory air leakage requirements. It also clarifies which test glazed overhead doors are to follow.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum da to Standard 90.1-2010

Revise Section 5.4.3.2 as follows: (I-P and SI units).

5.4.3.2 Fenestration and Doors. Air leakage for fenestration and doors shall be determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 400, or ASTM E283 as specified below. Air leakage shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council, and shall be labeled and certified by the manufacturer. Air leakage shall not exceed:

a. 1.0 cfm/ft^2 (18.3 m^3/h·m^2) for glazed swinging entrance doors and revolving doors, tested at a pressure of at least 1.57 psf (75 Pa) in accordance with AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 400, or ASTM E283.

b. 0.06 cfm/ft^2 (1.1 m^3/h·m^2) for curtainwall and storefront glazing, tested at a pressure of at least 1.57 psf (75 Pa) or higher in accordance with NFRC 400 or ASTM E283.

c. 0.3 cfm/ft^2 (5.5 m^3/h·m^2) for unit skylights having condensation weepage openings, when tested at a pressure of at least 1.57 psf (75 Pa) in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 200, or 0.5 cfm/ft^2 (9.1 m^3/h·m^2) when tested at a pressure of at least 6.24 psf (300 Pa) in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

d. 1.3 cfm/ft^2 (23.8 m^3/h·m^2) for nonswinging doors intended for vehicular access and material transportation, with a minimum opening rate of 32 in./s (0.81 m/sec), tested at a pressure of at least 1.57 psf (75 Pa) or higher in accordance with ANSI/DASMA 105, NFRC 400, or ASTM E283.

~~d~~e. 0.4 cfm/ft^2 (7.30 m^3/h·m^2) for other nonswinging opaque doors, and upward acting nonswinging glazed doors tested at a pressure of at least 1.57 psf (75 Pa) or higher in accordance with ANSI/DASMA 105, NFRC 400, or ASTM E283.

~~e~~f. 0.2 cfm/ft^2 (3.66 m^3/h·m^2) for all other products when tested at a pressure of at least 1.57 psf (75 Pa) in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400, or 0.3 cfm/ft^2 (5.5 m^3/h·m^2) when tested at a pressure of at least 6.24 psf (300 Pa) in accordance with AAMA/WDMA/CSA 101/I.S/A440.

Exceptions:

a. Field-fabricated fenestration and doors

b. Metal coiling doors in semiheated spaces in climate zones 1 through 6

c. Products in buildings that comply with a whole building air leakage rate of 0.4 cfm/ft^2 (7.32 m^3/h·m^2) under a pressure differential of 0.3 in. wg (1.57 psf) (2 L/s·m^2 at 75Pa) when tested in accordance with ASTM E 779

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FOREWORD

This addendum addresses an error introduced by ASHRAE/IES Standard 90.1-2010 addendum "bb", contained within Table 5.5-3, under the category "Floors, Steel Joist" and in the cells assigned to the "residential" occupancy.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum db to Standard 90.1-2010

Revise the Table 5.5-3 as follows (I-P and SI units).

Table 5.5-3 Building Envelope Requirements for Climate Zone 3 (A,B,C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum, I-P (SI)	Insulation Min. R-Value, I-P (SI)	Assembly Maximum	Insulation Min. R-Value
[. . .]						
Floors						
[. . .]						
Steel Joist	U-0.052	R-19	~~U-0.032~~ U-0.038 (~~U-0.183~~U-0.214)	~~R-38~~R-30 (~~R-6.7~~R-5.3)	U-0.052	R-19
[. . .]						

[. . .]

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FOREWORD

This proposal is intended to correct a possible flaw in previous proposed addenda "bc" and "by" in that there could be some confusion as to what to do when one room within a suite becomes empty. Do the lights in the bedroom turn off when the living room is empty? If the bedroom is still occupied, do the lights in the living room remain on? This proposal clarifies that each room is handled individually.

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Addendum dc to Standard 90.1-2010

Modify Section 9.4.1.6 c as follows (I-P and SI units).

9.4.1.6 Additional Control. Additional *controls* shall meet the following requirements:

[. . .]

c. Guest Room Lighting

1. The lighting in guestrooms ~~Guestrooms~~ in hotels, motels, boarding houses, or similar buildings shall be automatically controlled such that the lighting and switched receptacles in each enclosed space will shut off within 20 minutes after all occupants have left that space. ~~have one or more control device(s) at the entry door that collectively control all permanently installed luminaires and switched receptacles, except those in the bathroom(s). Suites shall have control(s) meeting these requirements at the entry to each room or at the primary entry to the suite.~~

Exception: Enclosed spaces where the lighting and switched receptacles are controlled by captive key systems and bathrooms are exempt.

2. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting~~, except for night lighting not exceeding 5 watts,~~ within ~~60~~ 30 minutes after all occupants have left the bathroom ~~of the occupant leaving the space~~.

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

If addendum "by" is published, these revisions will be as follows (I-P and SI units).

9.4.1.3 Special Applications

[. . .]

b. Guestrooms

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

Exception: Enclosed spaces where the lighting and switched receptacles are controlled by captive key systems and bathrooms are exempt. ~~Bathroom lighting and lighting and switched receptacles controlled by captive key systems are exempt from Section 9.4.1.3(b)(i).~~

2. Bathrooms shall have a separate control device installed to automatically turn off the bathroom lighting within 30 minutes after all occupants have left the bathroom ~~of the occupant leaving the space~~. Exception: Night lighting of up to 5 W per bathroom is exempt from Section 9.4.1.3(b)(ii).

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FOREWORD

This revision clarifies the exception to reroofing and roof recovering.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dd to Standard 90.1-2010

Add the following definitions to Section 3.2 (I-P and SI units).

roof covering: the topmost component of the roof assembly intended for weather resistance, fire classification, or appearance.

roof recovering: the process of installing an additional roof covering over an existing roof covering without removing the existing roof covering.

Revise exceptions to Section 5.1.3 (I-P and SI units).

5.1.3 Envelope Alterations

[. . .]

e. Roof recovering

f. Removal and replacement of a roof covering ~~membrane~~ where ~~either the roof sheathing or roof insulation is not exposed or, if~~ there is existing roof insulation~~,~~ integral to or below the roof deck.

~~f.~~g. [. . .]

~~g.~~h. [. . .]

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FOREWORD

This addendum revises the design point for water economizers, when utilized in computer-room applications, based on industry stakeholder feedback.

Unlike their commercial counterparts, buildings designed primarily to house computer rooms have relatively constant cooling loads throughout the year. Computer rooms typically do not have windows, so with ASHRAE required insulation, these building envelope loads run 1.2 to 1.5 W/ft^2 (13.3 to 16.7 W/m^2). ASHRAE recommends a ventilation rate of about 0.08 cfm/ft^2 for computer room facilities, which correlates to an additional 1.2 W/ft^2 (13.3 W/m^2) on a nominal 92°F db/76°F wb (33°C db/24.4°C db) design day. As such, ventilation and envelope loads are generally an insignificant portion of the overall cooling load as compared to contributions of 50 to 250 W/ft^2 (556 to 2778 W/m^2) or more from the IT equipment.

As in comfort cooling applications, the heat rejection load is reduced during winter economizer operation due to the elimination of compressor heat from the chiller (approximately 20% of the summer heat rejection load). Even so, computer room economizer loads remain at a much higher level than the typical HVAC application, which usually experiences a much greater drop off in load during the winter months.

Due to the psychrometric properties of air, cooling towers selected for computer-room water economizer applications are usually larger in terms of physical size and/or fan horsepower than what would be required for the standard summer design duty. This also tends to increase electrical service and structural mounting costs. These added costs are typically justified by the energy savings of the economizer. The larger cooling tower will also produce additional savings in the warmer months by producing colder condenser water and/or the ability to run at a reduced fan speed, saving cooling tower fan energy. For example, a cooling tower selected for an economizer duty of 51°F/43°F/35°F wb (10.6°C/6.1°C/1.7°C wb) can produce 80°F (26.7°C) condenser water versus the typical 85°F condenser water temperature at a 78°F (25.6°C) summer design wet bulb (10°F range in summer) at full fan horsepower. This will result in chiller energy savings of approximately 10% or more. Conversely, this same cooling tower can produce 85°F (29.4°C) condenser water with only 18% of the design tower fan energy.

Similarly, dry coolers used for computer room economizer duty are also oversized due to the high year-round heat load and the need to use aqueous glycol solutions as the heat transfer fluid in many climates. The colder the climate, the higher the percentage of glycol that must be used to prevent coil freezing. Furthermore, thermal performance decreases with increasing percentages of glycol.

Economizer use is not the norm in the computer room industry at this time, especially for legacy installations, which can be impacted by the new requirements due to renovations or expansions. Feedback from industry stakeholders, including ASHRAE TC9.9 (Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment) indicates that many designers are concerned about the impact of the economizer requirements on system reliability that were first introduced in the 2010 edition of the standard for many of the reasons listed above. Another major stakeholder concern is that many computer room facilities are only partially loaded for their first few years of operation, which can lead to system control issues, especially during the transition between operating modes.

To minimize the impact of these new economizer requirements on the industry and allow time for designers to adapt to these energy-saving methods, this addendum proposes that water economizers primarily serving computer rooms be designed for the dry bulbs and wet bulbs listed for each climate zone in Table 6.5.1.2.1 rather than use a fixed design value for all climate zones. These design temperatures were selected to reduce the relative sizing differential of the heat transfer devices (either cooling towers or dry coolers) between summer and winter duties yet still attain significant system energy savings for facilities located in these climate zones. As the industry adapts to these new economization requirements, it is expected that the required water economizer design temperatures will be increased in future editions of the standard in order to capture additional energy savings.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum de to Standard 90.1-2010

Revise Section 6.5.1.2.1 as follows (I-P and SI units).

6.5.1.2.1 Design Capacity. Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100% of the expected system cooling load at outdoor air temperatures of 50°F dry bulb/45°F wet bulb and below.

Exceptions:

a. Systems primarily serving computer rooms in which 100% of the expected system cooling load at <u>the</u> ~~40°F~~ dry bulb~~/~~<u> and the</u> ~~35°F~~ wet bulb listed <u>in Table 6.5.1.2.1 </u>is met with evaporative water economizers.

b. Systems primarily serving computer rooms ~~with dry cooler water economizers which satisfy~~ <u>in which </u>100% of the expected system cooling load at ~~35°F~~ <u>the </u>dry bulb<u> listed in Table 6.5.1.2.1 is met with dry cooler water economizers</u>.

c. Systems where dehumidification requirements cannot be met using outdoor air temperatures of 50°F dry bulb/45°F wet bulb and where 100% of the expected system cooling load at 45°F dry bulb/40°F wet bulb is met with evaporative water economizers.

TABLE 6.5.1.2.1 Water Economizer Sizing Dry-Bulb and Wet-Bulb Requirements for Computer Rooms (I-P)

Zone		Evaporative Water Economizer		Dry Cooler Water Economizer
		Dry-Bulb, °F	Wet-Bulb, °F	Dry-Bulb, °F
1	A	NR		NR
1	B	NR		NR
2	A	40.0	35.0	30.0
2	B	35.0	30.0	30.0
3	A	40.0	35.0	25.0
3	B	30.0	25.0	25.0
3	C	30.0	25.0	30.0
4	A	40.0	35.0	25.0
4	B	30.0	25.0	25.0
4	C	30.0	25.0	25.0
5	A	40.0	35.0	20.0
5	B	30.0	25.0	20.0
5	C	30.0	25.0	25.0
6	A	35.0	30.0	20.0
6	B	30.0	25.0	20.0
7	-	30.0	25.0	20.0
8	-	30.0	25.0	20.0

TABLE 6.5.1.2.1 Water Economizer Sizing Dry-Bulb and Wet-Bulb Requirements for Computer Rooms (SI)

Zone		Evaporative Water Economizer		Dry Cooler Water Economizer
		Dry-Bulb, °C	Wet-Bulb, °C	Dry-Bulb, °C
1	A	NR		NR
1	B	NR		NR
2	A	4.4	1.7	–1.1
2	B	1.7	–1.1	–1.1
3	A	4.4	1.7	–3.9
3	B	–1.1	–3.9	–3.9
3	C	–1.1	–3.9	–1.1
4	A	4.4	1.7	–3.9
4	B	–1.1	–3.9	–3.9
4	C	–1.1	–3.9	–3.9
5	A	4.4	1.7	–6.7
5	B	–1.1	–3.9	–6.7
5	C	–1.1	–3.9	–3.9
6	A	1.7	–1.1	–6.7
6	B	–1.1	–3.9	–6.7
7	-	–1.1	–3.9	–6.7
8	-	–1.1	–3.9	–6.7

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FOREWORD

This addendum changes the reference to the ANSI/CRRC Standard from the 2010 version to the 2012 version.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dg to Standard 90.1-2010

Modify Section 12 as follows (I-P and SI units).

Reference	Title
[. . .]	
Cool Roof Rating Council, **1610 Harrison Street, Oakland, CA 94612**	
ANSI/CRRC-1 Standard-~~2010~~2012	Cool Roof Rating Council—ANSI/CRRC-1 Standard
[. . .]	

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FOREWORD

The purpose of this addendum is to prohibit the use of fossil fuels and electricity for humidification above 30% RH and dehumidification to 60% RH, except in special circumstances. Where control is required within the 30%–60% region, a deadband is required. Where even tighter control is mandated, the system is exempted.

Where tight dehumidification control is needed, at least 75% of the amount of energy used for reheat shall be compensated for by recovered or site solar energy. For systems that dehumidify and reheat, but are not required to maintain conditions that require this, the requirement is increased to 90%.

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Addendum di to Standard 90.1-2010

Revise the standard as follows (I-P units).

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

Exceptions:

a. Zones served by desiccant systems, used with direct evaporative cooling in series.

b. Systems serving zones where specific humidity levels are required, such as museums and hospitals, and approved by the authority having jurisdiction or required by accreditation standards and humidity controls are configured to maintain a deadband of at least 10% RH where no active humidification or dehumidification takes place.

c. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% RH to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

[. . .]

6.5.2.3 Dehumidification. Where ~~humidistatic~~ humidity controls are provided, such controls shall prevent reheating, mixing of hot and cold airstreams, or other means of simultaneous heating and cooling of the same airstream.

Exceptions:

a. The system is configured to reduce ~~capable of reducing~~ supply air volume to 50% or less of the design airflow rate or to the minimum outdoor air ventilation rate specified in ASHRAE Standard 62.1 or other applicable federal, state, or local code or recognized standard, whichever is larger, before simultaneous heating and cooling takes place.

b. The individual fan cooling unit has a design cooling capacity of 65,000~~80,000~~ Btu/h (19~~23~~ kW) or less and is capable of unloading to 50% capacity before simultaneous heating and cooling takes place.

c. The individual mechanical cooling unit has a design cooling capacity of 40,000 Btu/h or less. An individual mechanical cooling unit is a single system composed of a fan or fans and a cooling coil capable of providing mechanical cooling.

d. Systems serving spaces where specific humidity levels are required to satisfy process needs, such as vivariums, museums, surgical suites, pharmacies, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas and the building includes site-recovered or site solar energy source that provide energy equal to at least 75% of the annual energy for reheating or for providing warm air in mixing systems. ~~(~~This exception does not apply to computer rooms.~~)~~

e. At least ~~75%~~90% of the annual energy for reheating or for providing warm air in mixing systems is provided from a site-recovered (including condenser heat) or site solar energy source.

f. Systems where the heat added to the airstream is the result of the use of a desiccant system and 75% of the heat added by the desiccant system is removed by a heat exchanger, either before or after the desiccant system with energy recovery.

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FOREWORD

This addendum offers an increase in electrical/mechanical rooms in cases where the current proposed allowance of 0.42 W/ft^2 (see addendum "by") is not considered sufficient to provide needed vertical and horizontal illuminance given the varied configuration of electrical/mechanical rooms. The additional allowance would have to have separate control and could not be traded off to other spaces in the building.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dj to Standard 90.1-2010

Revise Table 9.6.1 as follows: (I-P and SI units).

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method

Common Space Types[1]	LPD (W/ft^2)	RCR Threshold
[. . .]		
Electrical/Mechanical Room<u>[7]</u>	0.42	6
[. . .]		

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is not based on the RCR and shall be permitted when the width of the corridor is less than 8 ft.
3. An "Assisted Living Facility" is a residential facility, for people with special needs or disabilities, that provides help with everyday tasks such as bathing, dressing, and taking medication.
4. For accent lighting, see Section 9.6.2b.
5. Sometimes referred to as a "picking area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.
7. <u>An additional 0.53 W/ft^2 (5.7 W/m^2) shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.42 W/ft^2 (4.5 W/m^2). The additional 0.53 W/ft^2 (5.7 W/m^2) allowance shall not be used for any other purpose.</u>

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FOREWORD

This addendum eliminates the exemption for wattage used in spaces where lighting is specifically designed for those with age-related eye conditions or other medical conditions related to the eye, where special lighting or light levels might be needed. Newly developed addenda "bh" and "cr" now provide specific LPD values to address these issues and accommodate the needed lighting for such spaces, and the exception is no longer applicable. The 5 W per face limit for exit signs is now a federal product requirements and therefore no longer needed in the standard.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dk to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

9.2.2.3 Interior Lighting Power. The interior lighting power allowance for a building or a separately metered or permitted portion of a building shall be determined by either the Building Area Method described in Section 9.5 or the Space-by-Space Method described in Section 9.6. Trade-offs of interior lighting power allowance among portions of the building for which a different method of calculation has been used are not permitted. The installed interior lighting power identified in accordance with Section 9.1.3 shall not exceed the interior lighting power allowance developed in accordance with Section 9.5 or 9.6.

Exceptions: The following lighting equipment and applications shall not be considered when determining the interior lighting power allowance developed in accordance with Section 9.5 or 9.6, nor shall the wattage for such lighting be included in the installed interior lighting power identified in accordance with Section 9.1.3. However, any such lighting shall not be exempt unless it is an addition to general lighting and is controlled by an independent control device.

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

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

c. Lighting specifically designed for use only during medical or dental procedures and lighting integral to medical equipment

d. Lighting integral to both open and glass-enclosed refrigerator and freezer cases

e. Lighting integral to food warming and food preparation equipment

f. Lighting for plant growth or maintenance

~~g. Lighting in spaces specifically designed for use by occupants with special lighting needs including visual impairment and other medical and age-related issues~~

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

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

~~j.~~i. Lighting that is an integral part of advertising or directional signage

~~k.~~j. Exit signs

~~l.~~k. Lighting that is for sale or lighting educational demonstration systems

~~m.~~l. Lighting for theatrical purposes, including performance, stage, and film and video production

~~n.~~m. Lighting for television broadcasting in sporting activity areas

~~o.~~n. Casino gaming areas

~~p.~~o. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff and complies with Section 9.4.1.6(d)

~~q.~~p. Mirror lighting in dressing rooms and accent lighting in religious pulpit and choir areas

~~r.~~q. Parking garage transition lighting: Lighting for covered vehicle entrances and exits from buildings and parking structures, that comply with section 9.4.1.3 a and c. Each transition zone shall not exceed a depth of 66 ft inside the structure and a width of 50 ft

~~**9.4.2 Exit Signs.** Internally illuminated exit signs shall not exceed 5 W per face.~~

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FOREWORD

This addendum corrects the calculation of hotel and motel type guestroom spaces based on an error in applying the room geometry of the space type and combines them into a single value since the calculated values are determined to be the same for code purposes.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dl to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Building-Specific Space Types	LPD, W/ft^2 (m^2)	RCR Threshold
[. . .]		
~~Hotel Guest Rooms~~	~~1.11 (12.0)~~	~~6~~
[. . .]		
~~Highway Lodging Guest Rooms~~	~~0.75 (8.1)~~	~~6~~
Guest Room	0.91 (9.8)	6
[. . .]		

[a] In cases where both a common *space* type and a building-specific type are listed, the building specific *space* type shall apply.

If addendum "bh" is published, the following revisions will apply (I-P and SI units).

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types	LPD, W/ft^2 (m^2)	RCR Threshold
[. . .]		
Guest Room	~~0.47~~0.91 (~~5.1~~9.8)	6
[. . .]		

[a] In cases where both a common *space* type and a building-specific type are listed, the building specific *space* type shall apply.

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FOREWORD

The addendum adds a size limit for vestibules in large buildings; additionally, exemptions are added for semiheated spaces and for elevators in parking garages, provided that they have a lobby.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dm to Standard 90.1-2010

Revise the standard as follows for SI and I-P units.

5.4.3.4 Vestibules. Building entrances that separate conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. Interior and exterior doors shall have a minimum distance between them of not less than 7 ft (2.1 m) when in the closed position. The floor area of each vestibule shall not exceed the greater of 50 ft^2 (5 m^2) or 2% of the *gross conditioned floor area* for that level of the building. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. The interior and exterior envelope of unconditioned vestibules shall comply with the requirements for a *semiheated space*.

Exceptions:

a. *Building entrances* with revolving *doors*.
b. Doors not intended to be used as a *building entrance*.
c. *Doors* opening directly from a *dwelling unit*.
d. *Building entrances* in buildings located in climate zone 1 or 2.
e. *Building entrances* in buildings that are: located in climate zone 3~~,~~ ~~that are~~ less than four stories above grade~~,~~ and less than 10,000 ft^2 (1000 m^2) in *gross conditioned floor* area.
f. *Building entrances* in buildings that are located in climate zone 4, 5, 6, 7, or 8 and ~~that are~~ less than 1000 ft^2 (100 m^2) in *gross conditioned floor* area.
g. Doors that open directly from a space that is less than 3000 ft^2 in *gross conditioned floor* area and is separate from the *building entrance*.
h. *Semiheated spaces*.
i. Enclosed elevator lobbies for *building entrances* directly from parking garages.

5.4.3.4.1 Where vestibules are required under Section 5.4.3.4, for spaces having a *gross conditioned floor area* for that level of the building of 40,000 ft^2 (4000 m^2) and greater and when the doors opening into and out of the vestibule are equipped with automatic, electrically-driven, self-closing devices, the interior and exterior doors shall have a minimum distance between them of not less than 16 ft (4.8 m).

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FOREWORD

This addendum revises the requirements for the use of hot-gas bypass as defined in Section 6.5.9 and Table 6.5.9

The current requirements for hot-gas bypass are very high, with 50% allowed for systems with a capacity ≤240,000 Btu/h (70 kW) (20 tons) and 25% for units with a capacity >240,000 Btu/h.

Addendum "aq" added requirements for minimum stages of capacity with a minimum of three stages for 65,000 to 240,000 Btu/h and a requirement of 35% as the minimum stage of capacity and for greater than 240,000 Btu/h to have four stages and a minimum stage capacity of 25%

Based on this, there no need to have such large capacity allowances for hot-gas bypass, and the values should be reduced, which is the purpose of this addendum

For the 65,000 to 240,000 Btu/h, the addendum reduces the hot gas bypass capacity to 15%, which is a little less than the minimum stage of 35%. For >240,000 Btu/h, the minimum stage of capacity is 25%, so it is reasonable to reduce the hot gas bypass limit to 10%.

In addition, the addendum also eliminates the use of hot-gas bypass on DX constant-volume systems where modern controls can effectively cycle compressors to maintain capacity without the use of inefficient hot-gas bypass.

Below 65,000 Btu/h, most units are constant-volume, except for some new units which are being used for single-zone VAV. These units have multiple stages of capacity similar to the 65,000 to 240,000 Btu/h or have variable-speed capacity, so the requirement for 35% can be extended down to the smallest unit.

Note that addendum "aq" makes additional modifications to the hot-gas requirements. That addendum has been approved for publication.The first portion of this addendum shows what is changing in just this addendum relative to the most recent version of the standard approved for publication. The second portion shows all changes to this section from Standard 90.1-2010 if addendum "aq" and this addendum both are published.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dn to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

6.5.9 Hot-Gas Bypass Limitation. Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table 6.5.9 ~~and as limited by 6.5.1.3~~ for VAV units and single-zone VAV units. Hot-gas bypass shall not be used on constant-volume units.

TABLE 6.5.9 Hot-Gas Bypass Limitation

Rated Capacity	Maximum Hot Gas Bypass (% of Total Capacity)
≤240,000 Btu/h	~~50%~~15%
>240,000 Btu/h	~~25%~~10%

Revise Section 6.5.9 as follows if this addendum and addendum "aq" are both approved (I-P and SI units).

6.5.9 Hot-Gas Bypass Limitation. Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of the hot gas bypass shall be limited as indicated in Table 6.5.9 ~~and as limited by 6.5.1.3~~ for VAV units and single-zone VAV units. Hot-gas bypass shall not be used on constant-volume units.

~~**Exception:** Unitary packaged systems with cooling capacities not greater than 90,000 Btu/h.~~

TABLE 6.5.9 Hot-Gas Bypass Limitation

Rated Capacity	Maximum Hot Gas Bypass (% of Total Capacity)
≤240,000 Btu/h	~~50%~~15%
>240,000 Btu/h	~~25%~~10%

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FOREWORD

This addendum updates referenced standards in various provisions covering mechanical systems in ASHRAE/IES Standard 90.1-2010.

Note: In this addendum, changes to the current standard are indicated in the text by <u>underlining</u> (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum do to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

12. NORMATIVE REFERENCES

Reference	Title
Air Conditioning, Heating and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201	
[. . .]	
AHRI 550/590-2011 <u>with Addendum 1</u>	Water-Chilling Packages Using the Vapor Compression Cycle
[. . .]	
AHRI 1160-200~~8~~<u>9</u>	Performance Rating of Heat Pump Pool Heaters
Air Movement and Control Association International, 30 West University Drive, Arlington Heights, IL 60004-1806	
[. . .]	
<u>ANSI/</u>AMCA 500-D-~~07~~<u>12</u>	Laboratory Methods of Testing Dampers for Rating
[. . .]	
American National Standards Institute, 11 West 42nd Street, New York, NY 10036	
ANSI Z21.10.3-20~~04~~<u>11</u>	Gas Water Heater, Volume 3, Storage, with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous Water Heaters
ANSI Z21.47-20~~06~~<u>12</u>	Gas-Fired Central Furnaces ~~(Except Direct Vent and Separated Combustion System Furnaces)~~
[. . .]	
ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329	
ANSI/ASHRAE/IESNA Standard 90.1-20~~07~~<u>10</u>	Energy Standard for Buildings Except Low-Rise Residential Buildings
[. . .]	
ANSI/ASHRAE Standard 62.1-20~~07~~<u>10</u>	Ventilation for Acceptable Indoor Air Quality
[. . .]	
~~ANSI/ASHRAE 146-2006~~	~~Method of Testing for Rating Pool Heaters~~
[. . .]	
National Electrical Manufacturers Association, 1300 N. 17th Street, Suite 1847, Rosslyn, VA 22209	
ANSI/NEMA MG 1-20~~06~~<u>11</u>	Motors and Generators
National Fire Protection Association, 1 Battery March Park, P.O. Box 9101, Quincy, MA 02269-9101	
[. . .]	
NFPA 70 Article 708-20~~08~~<u>11</u>	Critical Operations Power Systems (COPS)
NFPA 96-~~94~~<u>12</u>	Ventilation Control and Fire Protection of Commercial Cooking Operations

Reference	Title
[. . .]	
Underwriters Laboratories, Inc. 333 Pfingsten Rd., Northbrook, IL 60062	
[. . .]	
UL 181B-~~2005~~05	Closure Systems for Use with Flexible Air Ducts and Air Connectors
UL 731-~~06~~12	UL Standard for Safety—Oil-Fired Unit Heaters
[. . .]	
[. . .]	

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FOREWORD

This addendum modifies language introduced in addendum ar to ASHRAE/IES Standard 90.1-2010. It revises the definition of walk-in cooler *to match the temperature definitions in federal regulations (Title 10—Energy, Chapter II—Department of Energy, Subchapter D—Energy Conservation, Part 431—Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart R—Walk-In Coolers and Walk-In Freezers, Section 431.302—Definitions Concerning Walk-In Coolers and Walk-in Freezers.)*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dp to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

3.2 Definitions

walk-in cooler: an enclosed storage space of less than 3000 ft^2 (280 m^2), designed to maintain space at >32°F (0°C) ~~but~~ and ≤55°F (13°C) that can be walked into.

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FOREWORD

This addendum is in response to a CMP and addresses two issues:

- *The economic analysis did not extend above a 24 in. (600 mm) pipe size, so requirements for larger pipes have been eliminated.*
- *Traditional hydronic design uses larger pipes in the smaller sizes in this table, especially for the columns with few hours per year of operation*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dq to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

TABLE 6.5.4.5 Piping System Design Maximum Flow Rate in GPL (I-P)

Operating Hours/Year	2000 h/yr		>2000 and 4400 h/yr		>4400 and 8760 h/yr	
Nominal Pipe Size (in.)	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**
2 1/2	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	530	260	400	210	320
5	410	620	310	470	250	370
6	740	1100	570	860	440	680
8	840	1300	650	970	510	770
10	1800	2700	1300	2000	1000	1600
12	2500	3800	1900	2900	1500	2300
Maximum velocity for pipes over ~~12~~ 14-24 in. in size	8.5 fps	13.0 fps	6.5 fps	9.5 fps	5.0 fps	7.5 fps

TABLE 6.5.4.5 Piping System Design Maximum Flow Rate in L/s (SI)

Operating Hours/Year	2000 h/yr		>2000 and 4400 h/yr		>4400 and 8760 h/yr	
Nominal Pipe Size (in.)	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**	**Other**	**Variable Flow/ Variable Speed**
75	8	11	5	8	4	7
90	11	17	9	13	7	11
110	22	33	16	25	13	20
140	26	39	20	30	16	23
160	47	69	36	54	28	43
225	53	82	41	61	32	49
280	114	170	82	126	63	101
315	158	240	120	183	95	145
Maximum velocity for pipes over ~~315~~ 355–600 mm in size	2.6 m/s	4.0 m/s	2.0 m/s	2.9 m/s	1.5 m/s	2.3 m/s

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FOREWORD

This addendum modifies the definition of building entrance *for clarity.*

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dr to Standard 90.1-2010

Revise Section 3 as follows (I-P and SI units).

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

[. . .]

3.2 Definitions

[. . .]

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

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FOREWORD

This addendum was generated in response to a continuous maintenance proposal to remove requirements to control lighting that is not part of the building permit to exempt some sign lighting in the lighting control wattage calculation.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dt to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

9.4.1.7 Exterior Lighting Control. Lighting for exterior applications not exempted in Section 9.1 shall meet the following requirements:

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

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

c. Lighting not specified in Section 4.1.7(b)~~, including~~ and lighting for ~~advertising~~ signage~~,~~ shall be controlled by a device that automatically reduces the connected lighting power by at least 30% for at least one of the following conditions:
   1. From 12 a.m. or within one (1) hour of the end of business operations, whichever is later, until 6 a.m. or business opening, whichever is earlier
   2. During any period when no activity has been detected for a time of no longer than 15 minutes

All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least ten hours.

Exceptions:

a. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation

b. Lighting that is integral to signage and installed in the signage by the manufacturer

[. . .]

9.4.3 Exterior Building Lighting Power. The total exterior lighting power allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are designed to be illuminated and are permitted in Table 9.4.3B for the applicable lighting zone. The installed exterior lighting power identified in accordance with Section 9.1.3 shall not exceed the exterior lighting power allowance developed in accordance with this section. Trade-offs are allowed only among exterior lighting applications listed in the Table 9.4.3B "Tradable Surfaces" section. The lighting zone for the building exterior is determined from Table 9.4.3A unless otherwise specified by the local jurisdiction.

Exceptions:

~~1.~~a. Lighting used for the following exterior applications is exempt when equipped with a control device that complies with the requirements of Section 9.4.1.7 and is independent of the control of the nonexempt lighting:

- ~~a. Specialized signal, directional, and marker lighting associated with transportation~~
- ~~b.~~1. ~~Advertising signage or directional signage.~~Lighting that is integral to signage and installed in the signage by the manufacturer
- ~~c. Lighting integral to equipment or instrumentation and installed by its manufacturer.~~
- ~~d. Lighting for theatrical purposes, including performance, stage, film production, and video production.~~
- ~~e.~~2. Lighting for athletic playing areas.
- ~~f. Temporary lighting.~~
- ~~g.~~3. Lighting for industrial production, material handling, transportation sites, and associated storage areas.
- ~~h.~~4. Theme elements in theme/amusement parks.
- ~~i.~~5. Lighting used to highlight features of public monuments and registered historic landmark structures or buildings.
- ~~j. Lighting for hazardous locations.~~
- ~~k~~6. Lighting for ~~swimming pools and~~ water features.
- ~~l. Searchlights.~~

b. Lighting used for the following exterior applications is exempt when controlled separately:
   1. Specialized signal, directional, and marker lighting associated with transportation
   2. Lighting integral to equipment or instrumentation and installed by its manufacturer
   3. Lighting for theatrical purposes, including performance, stage, film production, and video production
   4. Temporary lighting
   5. Lighting for hazardous locations
   6. Lighting for swimming pools
   7. Searchlights

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FOREWORD

The current wording of Section 6.5.4.2, "Pump Isolation" (which dates to ASHRAE/IESNA Standard 90.1-2004) says

> *When a chilled-water plant includes more than one chiller, provisions shall be made so that the flow in the chiller plant can be automatically reduced, correspondingly, when a chiller is shut down. Chillers referred to in this section, piped in series for the purpose of increased temperature differential, shall be considered as one chiller.*
>
> *When a boiler plant includes more than one boiler, provisions shall be made so that the flow in the boiler plant can be automatically reduced, correspondingly, when a boiler is shut down*

ASHRAE/IESNA Standard 90.1-1989 said

> *When a chilled water plant includes more than one chiller, no less than a corresponding number of chilled and condenser water pumps shall be provided, and either the piping arrangement or automatic valves shall allow a chilled and condenser water pump pair to shut off when one of the chillers shuts off. When a boiler plant includes more than one boiler, no less than a corresponding number of hot water pumps shall be provided, and either the piping arrangement or automatic valves shall allow a hot water pump to shut off when one of the boilers shuts off.*

This was written around the assumption that pumps are constant speed, which was the predominate practice at the time. The rewording was revised in ASHRAE/IESNA Standard 90.1-1999 apparently to address this problem.

California's Title 24 Energy Standards have similar requirements:

> 2. ***Chiller Isolation.*** *When a chilled water ~~plant~~system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.*
>
> 3. ***Boiler Isolation.*** *When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while maintaining flow through other operating boilier(s).*

The 1989 wording addressed two benefits of pump isolation:

1. *To reduce pump water flow to reduce pump energy.*
2. *To shut off flow through inactive chillers/boilers. This prevents dilution of the supply water temperature caused by flow through an inactive machine, which reduces efficiency in the active machines. For some boilers, it also prevents the boiler from losing heat up the flue.*

The Title 24 wording exclusively addresses the second issue, while the current wording of Section 6.5.4.2 only addresses the first. Since Section 6.5.4.1 requires most systems to be variable flow, and since system flow rate for variable-flow systems is more a function of valve demand than of how many pumps are on, the second issue is arguably more important, yet it is not addressed in the current standard. The first issue only needs be addressed for constant-flow systems where pumps are staged with the chillers or boilers. This addendum revises the current wording accordingly.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dv to Standard 90.1-2010

Revise the standard as follows (I-P and SI units).

6.5.4.2 Chiller and Boiler ~~Pump~~ Isolation~~.~~

6.5.4.2.1 When a chilled-water plant includes more than one chiller, provisions shall be made so that ~~the~~ all fluid flow through ~~in~~ the chiller ~~plant can be~~ is automatically ~~reduced~~ shut off~~, correspondingly,~~ when ~~a~~ the chiller is shut down. Chillers ~~referred to in this section,~~ piped in series for the purpose of increased temperature differential~~,~~ shall be considered as one chiller. Where constant-speed chilled-water or condenser water pumps are used to serve multiple chillers, the number of pumps shall be no less than the number of chillers and staged on and off with the chillers.

6.5.4.2.2 When a boiler plant includes more than one boiler, provisions shall be made so that the flow through ~~in~~ the boiler ~~plant can be~~ is automatically ~~reduced,~~ shut off ~~correspondingly,~~ when ~~a~~ the boiler is shut down. Where constant-speed hot-water pumps are used to serve multiple boilers, the number of pumps shall be no less than the number of boilers and staged on and off with the boilers.

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FOREWORD

Analysis has shown that temperature and humidity sensor measurement error has a large impact on energy performance of air economizer high-limit devices. The analysis shows that by far the most reliable device is the simply dry-bulb switch. Even with ±2°F (1.1°C) error, it is the best in most climates at setpoints that are adjusted by climate, lower in humid climates, and higher in dryer climates. Differential enthalpy sensors can have the worst performance of all devices because they have four sensors (return air dry bulb and RH and outdoor air dry bulb and RH) each of which can have error. This is true even with very accurate RH sensors, but studies at the Iowa Energy Center have shown that actual accuracy is much worse than nominal accuracy. Thus to ensure enthalpy high limits maintain good performance despite sensor error and when coils are dry, this addendum requires that they be used along with fixed dry-bulb switches.

Fixed dry-bulb switches set to 65°F (47°C) in humid climates are reinstated. They were allowed in ASHRAE/IESNA Standard 90.1-2007 and earlier versions at this setpoint. They were eliminated in 2010 due to concerns about high resulting space humidity, but that concern only applies to single-compressor DX units with two-stage thermostats, and the impact is minimized by the low 65°F (47°C) setpoint. With fully integrated economizers, high-limit switches have no space humidity impact.

Electronic enthalpy switches are eliminated because they have been supplanted in the marketplace by better-performing and lower-cost switches that use superior fixed enthalpy plus fixed dry-bulb logic.

The dew-point high limit that was added in the Standard 90.1-2004 is also deleted since it does not make sense theoretically and did not perform well in our simulations.

The addendum also adds tolerances to the high limit change over sensors that are aligned with tolerances recently added to the 2013 edition of Title 24.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum dw to Standard 90.1-2010

Revise Section 6 as follows (I-P and SI units).

6.5.1.1.3 High-Limit Shutoff. All air economizers shall be capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage. High-limit shutoff control types and associated setpoints for specific climate zones shall be chosen from Table 6.5.1.1.3~~A.~~ Control types not listed are prohibited in all climate zones. ~~High-limit shutoff control settings for these control types shall be those listed in Table 6.5.1.1.3B.~~

[. . .]

6.5.1.1.6 Sensor Accuracy. Outdoor air, return air, mixed air, and supply air sensors shall be calibrated within the following accuracies:

a. Dry-bulb and wet-bulb temperatures shall be accurate to ±2°F (1.1°C) over the range of 40°F to 80°F (4.4°C to 27°C).
b. Enthalpy and the value of a differential enthalpy sensor shall be accurate to ±3 Btu/lb (5 kJ/kg) over the range of 20 to 36 Btu/lb (35 to 63 kJ/kg).
c. Relative humidity shall be accurate to ±5% over the range of 20% to 80% RH.

~~**TABLE 6.5.1.1.3.A High-Limit Shutoff Control Options for Air Economizers**~~

~~Climate Zones~~	~~Allowed Control Types~~	~~Prohibited Control Types~~
~~1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8~~	~~Fixed dry bulb~~ ~~Differential dry bulb~~ ~~Electronic enthalpy[a]~~ ~~Differential enthalpy~~ ~~Dew-point and dry-bulb temperatures~~	~~Fixed enthalpy~~
~~1a, 2a, 3a, 4a~~	~~Fixed dry bulb~~ ~~Fixed enthalpy~~ ~~Electronic enthalpy[a]~~ ~~Differential enthalpy~~ ~~Dew-point and dry-bulb temperatures~~	~~Fixed dry bulb~~ ~~Differential dry bulb~~
~~5a and 6a~~	~~Fixed dry bulb~~ ~~Differential dry bulb~~ ~~Fixed enthalpy~~ ~~Electronic enthalpy[a]~~ ~~Differential enthalpy~~ ~~Dew-point and dry-bulb temperatures~~	

~~**TABLE 6.5.1.1.3.A High-Limit Shutoff Control Options for Air Economizers**~~

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

TABLE 6.5.1.1.3~~B~~ High-Limit Shutoff Control ~~Settings~~ Options and Setpoints for Air Economizers (I-P)

~~Device~~ Control Type	Allowed Only in Climate Zone at Listed Setpoint	Required High Limit Setpoint (Economizer Off when):	
		Equation	Description
Fixed dry-bulb temperature	1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	$T_{oa} > 75°F$	Outdoor air temperature exceeds 75°F
	5a, 6a	$T_{oa} > 70°F$	Outdoor air temperature exceeds 70°F
	1a, 2a, 3a, 4a,	$T_{oa} > 65°F$	Outdoor air temperature exceeds 65°F
Differential dry-bulb temperature	1b, 2b, 3b, 3c, 4b, 4c, 5a, 5b, 5c, 6a, 6b, 7, 8	$T_{oa} > T_{ra}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy with fixed dry-bulb temperature	~~2a, 3a, 4a, 5a, 6a~~ All	$h_{oa} > 28$ Btu/lb[a] or $T_{oa} > 75$	Outdoor air enthalpy exceeds 28 Btu/lb[a] or outdoor air temperature exceeds 75°F
~~Electronic enthalpy~~	~~All~~	~~$(T_{oa}, RH_{oa}) > A$~~	~~Outdoor air temperature/RH exceeds the "A" setpoint curve[b]~~
Differential enthalpy with fixed dry-bulb temperature	All	$h_{oa} > h_{ra}$ or $T_{oa} > 75$	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 75°F
~~Dew-point and dry-bulb temperatures~~	~~All~~	~~$DP_{oa} > 55°F$ or $T_{oa} > 75°F$~~	~~Outdoor air dry bulb exceeds 75°F or outside dew point exceeds 55°F (65 gr/lb)~~

a. At altitudes substantially different than sea level, the Fixed Enthalpy limit shall be set to the enthalpy value at 75°F and 50% relative humidity. As an example, at approximately 6000 ft elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.
~~b. Setpoint "A" corresponds to a curve on the psychrometric chart that goes through a point at approximately 75°F and 40% relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.~~
b. Devices with selectable rather than adjustable setpoints shall be capable of being set to within 2°F and 2 Btu/lb of the setpoint listed.

TABLE 6.5.1.1.3~~B~~ High-Limit Shutoff Control ~~Settings~~ Options and Setpoints for Air Economizers (SI)

~~Device~~ Control Type	Allowed Only in Climate Zone at Listed Setpoint	Required High Limit Setpoint (Economizer Off when):	
		Equation	Description
Fixed dry-bulb temperature	1b, 2b, 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	$T_{oa} > 24°C$	Outdoor air temperature exceeds 24°C
	5a, 6a	$T_{oa} > 21°C$	Outdoor air temperature exceeds 21°C
	1a, 2a, 3a, 4a,	$T_{oa} > 18°C$	Outdoor air temperature exceeds 18°C
Differential dry-bulb temperature	1b, 2b, 3b, 3c, 4b, 4c, 5a, 5b, 5c, 6a, 6b, 7, 8	$T_{oa} > T_{ra}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy with fixed dry-bulb temperature	~~2a, 3a, 4a, 5a, 6a~~ All	$h_{oa} > 47$ kJ/kg[a] or $T_{oa} > 24°C$	Outdoor air enthalpy exceeds 47 kJ/kg[a] or outdoor air temperature exceeds 24°C
~~Electronic enthalpy~~	~~All~~	~~$(T_{oa}, RH_{oa}) > A$~~	~~Outdoor air temperature/RH exceeds the "A" setpoint curve[b]~~
Differential enthalpy with fixed dry-bulb temperature	All	$h_{oa} > h_{ra}$ or $T_{oa} > 24°C$	Outdoor air enthalpy exceeds return air enthalpy or outdoor air temperature exceeds 24°C
~~Dew-point and dry-bulb temperatures~~	~~All~~	~~$DP_{oa} > 13°C$ or $T_{oa} > 24°C$~~	~~Outdoor air dry bulb exceeds 24°C or outside dew point exceeds 13°C (0.009kg/kg)~~

TABLE 6.5.1.1.3~~B~~ High-Limit Shutoff Control ~~Settings~~ Options and Setpoints for Air Economizers (SI)

a. At altitudes substantially different than sea level, the fixed enthalpy limit shall be set to the enthalpy value at 24°C and 50% RH. As an example, at approximately 1830 m elevation the fixed enthalpy limit is approximately 53.5 kJ/kg.
~~b. Setpoint "A" corresponds to a curve on the psychrometric chart that goes through a point at approximately 24°C and 40% RH and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.~~
b. Devices with selectable rather than adjustable setpoints shall be capable of being set to within 1.1°C and 3.4 kJ/kg of the setpoint listed.

Revise the standard as follows (I-P and SI units).

TABLE 11.3.2D Economizer High-Limit Shutoff

Economizer Type	High-Limit Shutoff
Air	Table 6.5.1.1.3~~B~~
Water (integrated)	When its operation will no longer reduce HVAC system energy
Water (nonintegrated)	When its operation can no longer provide the cooling load

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INFORMATIVE APPENDIX—
2013 ADDENDA TO ANSI/ASHRAE/IES STANDARD 90.1-2010

This supplement includes Addenda e, f, i, l, m, n, q, r, u, w, aa, ad, ae, af, ag, ah, ai, aj, ak, al, am, an, ap, aq, ar, as, at, au, av, aw, ax, ay, az, ba, bb, bc, bd, be, bf, bg, bh, bi, bj, bk, bl, bn, bo, bp, bq, br, bs, bt, bv, bw, bx, by, ca, cb, cc, cd, ce, cf, ch, cj, ck, cl, cm, cn, co, cp, cr, ct, cv, cy, cz, da, db, dc, dd, de, dg, di, dj, dk, dl, dm, dn, do, dp, dq, dr, dt, dv, and dw to ANSI/ASHRAE/IES Standard 90.1-2010. The following table lists each addendum and describes the way in which the standard is affected by the change. It also lists the ASHRAE, IES, and ANSI approval dates for each addendum.

2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
bb (formerly Addendum bb to 90.1-2007)	5. Building Envelope; Appendix A	This addenda modifies the building envelope requirements for opaque assemblies and fenestration in tables 5.5.1 through 5.5.8 and the associated text in section 5.5.4.5. It also updates the NFRC 301 reference and modifies two metal building roof assemblies in Table A2.3.	3/23/2012	4/4/2012	3/23/2012	5/11/2012
cj (formerly Addendum cj to 90.1-2007)	Appendix G	Creates modeling rules for computer rooms in Appendix G	6/26/2013	6/26/2013	6/28/2013	7/24/2013
cm (formerly Addendum cm to 90.1-2007)	5. Building Envelope	The proposed text clarifies how to interpret the use of dynamic glazing products given the requirements in Addendum bb (envelope requirements).	7/20/2010	7/23/2010	7/24/2010	7/26/2010
dm (previously from 2007)	5. Building Envelope	This addenda modifies section 5.4.3.4. for vestibules. It adds a size limit for large buildings, exemptions for semi heated spaces and elevator lobbies in parking garages	1/26/2013	1/29/2013	2/11/2013	2/12/2013
e	Appendix G	This addendum updates language in Section G3.1, part 5 'Building Envelope', to require that existing buildings use the same envelope baseline as new buildings with the exception of fenestration area.	6/27/2012	6/27/2012	6/18/2012	7/26/2012
f	Appendix G	This addendum modifies Section G.3.1, Building Envelope. It specifies the vertical fenestration area for calculating baseline building performance for new buildings and additions.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
i	6. Heating, Ventilating, and Air Conditioning	This addendum increases the minimum efficiency standards for SPVAC and SPVHP. It also creates a new product class for SPVAC and SPVHP used in space constrained applications. This new product class only applies to non-weatherized products with cooling capacities <36,000 Btu/h and intended to replace an existing AC.	1/26/2013	1/29/2013	2/11/2013	2/12/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
l	6. Heating, Ventilating, and Air Conditioning	This addendum fixes the mistake with 90.1-2010 fan power limitations which required the user to perform calculations for fan bhp even if the simplified nameplate hp option was being used.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
m	9. Lighting	This addendum adds some control requirements for lighting alterations, for interior and exterior applications. It adds a section for submittals and includes loading docks as a tradable surface. It modifies the provisions for additional interior lighting power, which would now be calculated on the basis of controlled wattage.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
n	10. Other Equipment	This addendum clarifies that the total lumens/watt for the entire elevator cab is required to meet the efficiency requirement and it is not required for each individual light source.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
q	5. Building Envelope; 3. Definitions; 12. Normative References	This addendum modifies Section 5.8.2.2, by clarifying the requirements for labeling of fenestration and door products. The corresponding references to NFRC in Chapter 12 have also been updated.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
r	12. Normative References; Appendix G	This addendum clarifies the requirements related to temperature and humidity control in Appendix G and relocates all related wording to the Schedules section of Table3.1. Additionally, clarity is provided for modeling systems that provide occupant thermal comfort via means other than other than directly controlling the air dry bulb and wet-bulb temperature (i.e. radiant cooling/heating, elevated air speed, etc.). It permits the use of ASHRAE Standard 55 for calculation of PMV-PPD. This addendum also updates the Normative References by including a reference to ASHRAE Standard 55-2010.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
u	6. Heating, Ventilating, and Air Conditioning	This addendum adds new definition as Fan Efficiency Grade (FEG) and requires each fan has a FEG of 67 or higher as defined by AMCA205-10 (Energy Efficiency Classification for Fans)	1/26/2013	1/29/2013	2/11/2013	2/12/2013
w	3. Definitions; 11. Energy Cost Budget Method; Appendix G	This addendum adds definitions for on-site renewable energy and purchased energy. It clarifies the process for accounting for on-site renewable energy and purchased energy as well as calculating the annual energy costs in the ECB approach and Appendix G.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
aa	6. Heating, Ventilating, and Air Conditioning	Prior to this addendum certain controls requirements were only required when the controls were provided by a DDC system. This addendum eliminates that contingency for set point overlap restrictions, humidification and dehumidification controls, VAV fan control set point reset, multiple-zone VAV system ventilation optimization control, hydronic system design and control, and instead specifies how the system must perform. This will in effect require DDC for systems where these controls are needed.	7/26/2013	7/30/2013	7/29/2013	7/31/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ad	12. Normative References	Adds reference to specific addenda to AHRI standards 340/360 and 130 being referenced	6/27/2012	6/27/2012	6/18/2012	6/28/2012
ae	12. Normative References	Adds reference to specific addenda to AHRI standards 210/240 and 550/590 being referenced	7/26/2013	7/30/2013	7/29/2013	8/28/2013
af	6. Heating, Ventilating, and Air Conditioning	Modifies heat rejection equipment (cooling tower) requirements to require VSDs on fans, operate all fans at the same speed instead of sequencing them, and require that systems with multiple condenser water pumps operate those pumps in parallel at reduced flow.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
ag	Appendix G	Establishes a method for gaining credit in Appendix G for buildings that undergo whole building air leakage testing to demonstrate that they have an air-tight building.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ah	Appendix G	Sets system sizing requirements in appendix G for humid climates based on humidity ratio instead of SA delta T. Sets baseline system dehumidification requirements.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
ai	Appendix G	Modifies Appendix G to account for 3 prescriptive addenda that were incorporated in to standard 90.1-2010, but did not make it into Appendix G in time for publication. Updates economizer requirements to match addendum cy, establishes baseline transformer efficiency requirements to match addendum o, and establishes path A for centrifugal chiller baselines from addendum m.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
aj	6. Heating, Ventilating, and Air Conditioning	Requires fractional horsepower motors >= 1/22 hp to EC motors or minimum 70% efficient in accordance with DOE 10 CFR 431. Also requires adjustable speed or other method to balance airflow.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
al	Appendix G	Establishes a consistent fuel source for space heating for baseline systems based on climate zone. Establishes a consistent fuel source for service water heating based on building type.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
am	6. Heating, Ventilating, and Air Conditioning	Establishes minimum turndown for boilers and boiler plants with of at least 1,000,000 Btu/h.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
an	Appendix C	Rewrites entire Appendix C to use a simulation based approach for envelope trade-offs.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ap	6. Heating, Ventilating, and Air Conditioning	Adds Power Utilization Effectiveness (PUE) as an alternative compliance methodology for data centers.	1/26/2013	1/29/2013	2/11/2013	5/3/2013
aq	6. Heating, Ventilating, and Air Conditioning; 11. Energy Cost Budget	This addendum makes changes to the requirements for fan control for both constant volume and VAV units including extending the fan part load power requirements down to ¼ HP In addition it defines the requirements for integrated economizer control and defines DX unit capacity staging requirements	6/26/2013	6/26/2013	6/28/2013	7/1/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ar	6. Heating, Ventilating, and Air Conditioning	Adds mandatory and prescriptive requirements for walk-in coolers and freezers and refrigerated display cases.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
as	6. Heating, Ventilating, and Air Conditioning	Avoidance of simultaneous heating and cooling at AHU. Requires humidifiers mounted in the airstream to have an automatic control valve shutting off preheat when humidification is not required, and insulation on the humidification system dispersion tube surface.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
at	3. Definitions; 5. Building Envelope; 9. Lighting	Deletes the term clerestory and instead adds roof monitor and clarifies the definition. Changes the references in Chapters 5 and 9 from clerestory to roof monitor.	6/27/2012	6/27/2012	6/18/2012	6/28/2012
au	6. Heating, Ventilating, and Air Conditioning	This addendum modifies Table 6.5.3.1.1B which addresses fan power limitation pressure drop adjustment credits. Deductions are added for systems without any central heating or cooling as well as systems with electric resistance heating. Sound attenuation credit is modified to be available only when there are background noise criteria requirements.	1/26/2013	1/29/2013	2/11/2013	2/12/2013
av	6. Heating, Ventilating, and Air Conditioning	This addendum modifies Section 6.5.1, exception k, applicable to Tier IV data centers, in an attempt to make economizer exceptions more strict and in agreement with ASHRAE TC 9.9	6/26/2013	6/26/2013	6/28/2013	7/24/2013
aw	11. Energy Cost Budget; Appendix G	This addendum updates the reference year for ASHRAE Standard 140 and exempts software used for ECB and Appendix G compliance from having to meet certain sections of ASHRAE Standard 140	1/26/2013	1/29/2013	2/11/2013	2/12/2013
ax	Appendix G	Table G3.1 Part 14 of Appendix G is modified to exclude the condition which permits a building surface, shaded by an adjacent structure, to be simulated as north facing if the simulation program is incapable of simulating shading by adjacent structures.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
ay	3. Definitions; 9. Lighting	This addenda modifies daylighting requirements. It modifies definitions for daylight area under skylights, daylight area under roof monitors, primary sidelight area, secondary sidelight area. It modifies the thresholds for applying automatic daylighting control for sidelighting and toplighting, to a wattage basis and provides characteristics for the required photo controls. It modifies Table 9.6.2 to include continuous dimming in secondary sidelighted areas, which is now based on a W level rather than area of the space. It eliminates the need for effective aperture calculation.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
az	6. Heating, Ventilating, and Air Conditioning	This addendum increases the minimum efficiency of open circuit axial fan cooling towers. An additional requirement has been added which states that the minimum efficiency requirements for all types of cooling towers also applies to accessories which affect the thermal performance of the unit. An additional footnote clarifies that the certification requirements do not apply to field erected cooling towers.	1/26/2013	1/29/2013	2/11/2013	2/12/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ba	6. Heating, Ventilating, and Air Conditioning	Adds requirements for door switches to disable or reset mechanical heating or cooling when doors are left open.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
bc	9. Lighting	Modifies requirements for automatic lighting control for guestroom type spaces. Exception to this requirement are lighting and switched receptacles controlled by captive key systems.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
bd	9. Lighting	This addenda adds more specific requirements for the functional testing of lighting controls, specifically, occupancy sensors, automatic time switches and daylight controls.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
be	9. Lighting	Minor revisions to Section 9.7.2.2, which addresses the scope of the operating and maintenance manuals required for lighting equipment and controls.	1/26/2013	1/29/2013	2/11/2013	2/12/2013
bf	8. Power	This addenda addresses Section 8.4.2 on automatic receptacle control and increases the spaces where plug shutoff control is required. It also clarifies the application of this requirement for furniture systems, states a labeling requirement to distinguish controlled and uncontrolled receptacles and restricts the use of plug-in devices to comply with this requirement.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
bg	5. Building Envelope	Requirements for low E storm window retrofits.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bh	9. Lighting	Modifies Table 9.6.1 Space-By-Space Lighting Power Density allowance	7/26/2013	7/30/2013	8/12/2013	9/4/2013
bi	6. Heating, Ventilating, and Air Conditioning	Increase SEER and HSPF for air-cooled commercial air conditioners and heat pumps below 65,000 Btu/h. Effective 1/1/2015	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bj	6. Heating, Ventilating, and Air Conditioning	Re-establishes the product class for Small Duct High Velocity (SDHV) air conditioners and heart pumps. Adds efficiency requirements for systems at <65.000 Btuh	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bk	6. Heating, Ventilating, and Air Conditioning	Increases cooling efficiency for PTACs	1/26/2013	1/29/2013	2/11/2013	2/12/2013
bl	11. Energy Cost Budget; Appendix G	Provide rules for removing fan energy from efficiency metrics when modeling in ECB or Appendix G.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bn	8. Power; 10. Other Equipment	Establishes electric and fuel metering requirements	7/26/2013	7/30/2013	7/29/2013	9/4/2013
bo	6. Heating, Ventilating, and Air Conditioning	Requires buildings with SW capacity >= 1million but/h to have average efficiency of at least 90%. Updates Table 7.8 to reflect federal requirements for electric water heaters. Updates the reference standard for swimming pool water heaters to ASHRAE Standard 146.	7/26/2013	7/30/2013	7/29/2013	9/4/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
bp	6. Heating, Ventilating, and Air Conditioning	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G for evaporative condensers with ammonia refrigerants	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bq	6. Heating, Ventilating, and Air Conditioning	Improve efficiency of commercial refrigeration systems	1/26/2013	1/29/2013	2/11/2013	2/12/2013
br	10. Other Equipment	Updates motor efficiency tables	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bs	6. Heating, Ventilating, and Air Conditioning	Reduce occupancy threshold for demand controlled ventilation from greater than 40 people per 1000 ft2 to equal to or greater than 25 people per 1000 ft2 with exemptions for certain occupancies.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
bt	6. Heating, Ventilating, and Air Conditioning	Reduces the threshold at which energy recovery is required. Relaxed in some climate zones.	6/26/2013	6/26/2013	6/28/2013	7/24/2013
bv	9. Lighting	Reduces the threshold at which skylights and daylighting controls are required for high bay spaces.	6/26/2013	6/26/2013	6/28/2013	7/1/2013
bw	5. Building Envelope	Modifies orientation requirements and adds SHGC tradeoff	7/26/2013	7/30/2013	7/29/2013	8/28/2013
bx	9. Lighting	Clarification of exceptions to occupancy sensor requirements	1/26/2013	1/29/2013	2/11/2013	2/12/2013
by	9. Lighting	Improves and enhances lighting controls requirements. Establishes table of lighting controls applicable to each space type. Corrects daylighting threshold.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ca	5. Building Envelope	Adds control requirements for heating systems in vestibules	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cb	6. Heating, Ventilating, and Air Conditioning	This addendum requires night setback 10F heating & 5F cooling and removes exception for systems less than 10,000 cfm min for optimum start	7/26/2013	7/30/2013	7/29/2013	8/28/2013
cc	6. Heating, Ventilating, and Air Conditioning	Adds efficiency requirements (Btu/h-hp) to Table 6.8.1G for evaporative condensers with R-507A	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cd	6. Heating, Ventilating, and Air Conditioning	Provides definition for piping to include all accessories in series with pipe such as pumps, valves, strainers, air separators, etc. This is meant to clarify that these accessories need to be insulated.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
ce	Appendix G	Establishes a baseline system type for retail occupancies less than 3 stories in Appendix G	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cf	Appendix G	Establishes baseline WWR in Appendix G for strip malls.	7/26/2013	7/30/2013	7/29/2013	8/28/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
ch	6. Heating, Ventilating, and Air Conditioning	Improved air and water cooled chiller efficiencies in Table 6.8.1C. Exempts water cooled positive displacement chillers with leaving condenser temperature >= 115 deg.F. (typically heat reclaim chillers).	6/26/2013	2/26/2013	6/28/2013	7/1/2013
ck	6. Heating, Ventilating, and Air Conditioning	Requires VAV dual maximum damper position when DDC system is present	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cl	6. Heating, Ventilating, and Air Conditioning	Table 6.8.1A and B. Improves IEER requirements for air-cooled air conditioners and heat pumps and EER requirements for water and evaporatively-cooled air-conditioners and heat pumps.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cn	Appendix G	Establishes modeling rules for laboratories with 100% OA in Appendix G	6/26/2013	6/26/2013	6/28/2013	7/1/2013
co	9. Lighting	Comprehensive update of LPDs in Table 9.5.1 - Building Area Method	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cp	5. Building Envelope	Corrects non-residential U-factor and R-value requirements for steel joist floors in CZ3	6/26/2013	6/26/2013	6/28/2013	7/1/2013
cr	9. Lighting	Makes a number of adjustments to Table 9.6.1 Space-by-space LPD	7/26/2013	7/30/2013	7/29/2013	7/31/2013
ct	Appendix G	Identifies heated only storage systems 9 and 10 in Appendix G as being assigned one system per thermal zone.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cv	Appendix G	Establishes baseline system types in Appendix G for Assembly occupancies.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cy	6. Heating, Ventilating, and Air Conditioning	More stringent energy recovery for 24/7 occupancies	7/26/2013	7/30/2013	7/29/2013	7/31/2013
cz	6. Heating, Ventilating, and Air Conditioning	Increases boiler efficiency for residential sized (NAECA covered) equipment, <3,000 Btu/h	7/26/2013	7/30/2013	7/29/2013	7/31/2013
da	5. Building Envelope	Relaxes air leakage requirements for high-speed doors for vehicle access and material transport	7/26/2013	7/30/2013	7/29/2013	8/28/2013
db	5. Building Envelope	Corrects residential U-factor and R-value requirements for steel joist floors in CZ3	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dc	9. Lighting	Clarifies automatic lighting and switched receptacle control in guest rooms as applied to individual spaces.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dd	5. Building Envelope	Clarifies roof insulation requirements, differentiating between roof recovering (on top of existing roof covering) and replacement of roof covering.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
de	6. Heating, Ventilating, and Air Conditioning	Relaxes design requirements for waterside economizers for computer rooms	7/26/2013	7/302013	7/29/2013	7/31/2013
dg	5. Building Envelope	Updates reference to ANSI/CRRC-l Standard 2012 (cool roof ratings)	7/26/2013	7/30/2013	7/29/2013	7/31/2013

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2013 Addenda to ANSI/ASHRAE/IES Standard 90.1-2010 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	ASHRAE BOD Approval	IES BOD Approval	ANSI Approval
di	6. Heating, Ventilating, and Air Conditioning	Establishes limits on using electric or fossil fuel to humidify or dehumidify between 30% & 60% RH except certain applications. Requires deadband on humidity controls.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dj	9. Lighting	Additional lighting power allowance for electrical/mechanical rooms provided there is separate control for additional lighting.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dk	9. Lighting	Eliminates the exemption for wattage used in spaces where lighting is specifically designed for those with age-related eye conditions or other medical conditions related to the eye, where special lighting or light levels might be needed.	7/26/2013	7/30/2013	7/29/2013	8/28/2013
dl	9. Lighting	Modifies hotel and motel guest room lighting power density	7/26/2013	7/30/2013	7/29/2013	8/28/2013
dn	6. Heating, Ventilating, and Air Conditioning	Reduces the limits on hot gas bypass as a means of cooling capacity control.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
do	6. Heating, Ventilating, and Air Conditioning	Update references to AHRI 550, AMCA 500, ANSI Z21.10.3 & Z21.47, ASHRAE 90.1 & 62.1, NEMA MG 1, & NFPA 70 &96	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dp	6. Heating, Ventilating, and Air Conditioning	Corrects the definition of walk-in-cooler to be consistent with federal requirements.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dq	6. Heating, Ventilating, and Air Conditioning	Deletes sizing requirements for pipes >24 in.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dr	5. Building Envelope	Clarifies definition of building entrances to exclude electrical room, mechanical rooms, and other utility service entrances.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dt	9. Lighting	Added exceptions for control of exterior lighting integral to signage. Requires certain types of exterior lighting exempt from LPD requirements to be separately controlled.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dv	6. Heating, Ventilating, and Air Conditioning	Establishes chiller and boiler fluid flow isolation requirements so there is no flow through the equipment when not in use.	7/26/2013	7/30/2013	7/29/2013	7/31/2013
dw	6. Heating, Ventilating, and Air Conditioning	Revises high limit shutoff for air economizers. Add sensor accuracy requirements.	7/26/2013	7/30/2013	7/29/2013	7/31/2013

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NOTE

When addenda, interpretations, or errata to this standard have been approved, they can be downloaded free of charge from the ASHRAE Web site at http://www.ashrae.org.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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