CHAPTER 7
ENERGY EFFICIENCY

701.1 (7.1) Scope This section specifies requirements for energy efficiency for buildings and appliances, and for *on-site renewable energy systems,* and for energy measuring.

701.2(7.2) Compliance The energy systems shall comply with Section 701.3 (7.3), "Mandatory Provisions," and either
a. Section 701.4 (7.4), "Prescriptive Option, " or
b. Section 701.5 (7.5), "Performance Option."

701.3 (7.3) Mandatory Provisions

701.3.1 (7.3.1)General *Building projects* shall be designed to comply with Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 of ANSI/ASHRAE/ES Standard 90.1.

701.3.2 (7.3.2) On-Site Renewable Energy Systems *Building project* design shall show allocated *space* and pathways for future installation of *on-site renewable energy systems* and associated infrastructure that provide the annual energy production equivalent of not less than 1.75 kWh/ ft^2 for single-story buildings and not less than 3.0 kWh/ ft^2 multiplied by the *gross roof area* in feet squared (metres squared) for all other buildings.

Exceptions:

1. *Building projects* that have an annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 1.2 kBtu/ft^2-day (4.0 kWh/ m^2-day), accounting for existing buildings, permanent infrastructure that is not part of the *building project,* topography, or trees.
2. *Building projects* that comply with Section 701.4.1.1 (7.4.1.1).

701.3.3 (7.3.3) Energy Consumption Management

701.3.3.1 (7.3.3.1)Consumption Management Measurement devices with remote communication capability shall be provided to collect energy consumption data for each energy supply source to the building (including gas, electricity, and district energy) that exceeds the thresholds listed in Table 701.3.3.1A (7.3.3.1A). The measurement devices shall have the capability to automatically communicate the energy consumption data to a data acquisition system.

TABLE 701.3.3.1A (TABLE 7.3.3.1A)
ENERGY SOURCE THRESHOLDS

ENERGY SOURCE	THRESHOLD
Electrical service	> 200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	> 1, 000, 000 Btu/h (300 kW)
Geothermal energy	> 1, 000, 000 Btu/h (300 kW) heating
On-site renewable thermal energy	> 100, 000 Btu/h (30 kW)

701.4 (7.4) Prescriptive Option

701.4.1 (7.4.1)General Comprehensive Prescriptive Requirements When a requirement is provided below, it supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ANSI/ASHRAE/IES Standard 90.1.

701.4.1.1 (7.4.1.1)On-Site Renewable Energy Systems All Building projects shall complete a On-site Renewable Energy Economic Feasibility Study. This study shall include the following elements:

1. Calculated total available roof area for renewable systems. This area shall include areas not shaded by parapets, free from mechanical equipment, and required walkways.
2. Economic feasibility of maximum renewable system on available roof
3. Economic feasibility of minimum renewable system on available roof
    a. Minimum System size is based on annual energy production equivalent of not less than 1.75 kWh/ ft^2 multiplied by the horizontal projection of the gross roof area in feet squared (metres squared) for single-story buildings, and not less than 3.0 kWh/ ft^2 multiplied by the horizontal projection of the gross roof area in feet squared (metres squared) for all other buildings.

All buildings with a On-site Renewable Energy Economic Feasibility Study that shows the minimum system is feasible shall install a system of equivalent size.

Exceptions:

1. A commitment to purchase renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity Products, of at least 7 kWh/ft^2(75 kWh/m^2) of conditioned space each year until the cumulative purchase totals 70 kWh/ft^2(750 kWh/m^2) of conditioned space
2. Project install an equivalent system on a similar project in the jurisdiction
3. Project utilizes energy performance approach and shows energy efficient measures that off set energy equivalent to the proposed system.

701.4.2 (7.4.2)Building Envelope The *building envelope* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 5, with the following modifications and additions.

701.4.2.1 (7.4.2.1)Building Envelope Requirements The *building envelope* shall comply with the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8, with the following modifications to values in each table. For the opaque elements, each U-factor, C-factor, and F-factor in Tables 5.5-4 through 5.5-8 shall be reduced by 5%. The "Insulation Min. R-Value" column in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8, shall not apply. For *vertical fenestration* and *skylights,* each U-factor shall be reduced by 5%. For *skylights* and east- and west-oriented *vertical fenestration,* each *solar heat gain coefficient (SHGC)* in Tables 5.5-0 through 5.5-8 shall be reduced by 5%.

Exceptions:

1.The U-factor, C-factor, or F-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8.

2.The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8.

3.*Spaces* that meet the requirements of Section 801.4.1 (8.4.1), regardless of *space* area, are exempt from the *SHGC* criteria for *skylights.*

Informative Notes:

1.U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ ASHRAE/IES Standard 90.1, Normative Appendix A.

2.Section 501.3.5.3 (5.3.5.3) of this code includes additional provisions related to *roofs.*

701.4.2.2 (7.4.2.2)Single-Rafter Roof Insulation *Single-rafter roofs* shall comply with the requirements in Normative Appendix A, Table A101.1 (A-1). These requirements supersede the requirements in ANSI/ ASHRAE/IES Standard 90.1, Section A2.4.2.4. ANSI/ ASHRAE/IES Standard 90.1, Section A2.4.2.4 and Table A2.4.2, shall not apply.

701.4.2.3 (7.4.2.3)High-Speed Doors *High-speed doors* that are intended to operate on average at least 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h-ft^2-°F (6.81 W/m^2-K). Opening rate, closing rate, and average cycles per day shall be included in construction drawings. ANSI/ASHRAE/IES Standard 90.1, Sections 5.5.3.6 and 5.5.4.3, shall not apply for *high-speed doors* complying with all criteria in this section.

701.4.2.4 (7.4.2.4)Air Curtains Where air curtains are provided at *building entrances* or *building entrance* vestibules, for the distance from the air-curtain discharge nozzle to the floor, the air-curtain unit shall produce a minimum velocity of 6.6 ft/s (2.0 m/s), in accordance with ANSI/AMCA 220, and be installed in accordance with manufacturer's instructions. *Automatic* controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section 1001.3.1.2.1 (10.3.1.2.1).

701.4.2.5 (7.4.2.5)Vertical Fenestration Area The total *vertical fenestration area* shall be less than 40% of the *gross wall area.* This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.2.1.

701.4.2.6 (7.4.2.6)Permanent Projections For *Climate Zones* 0 through 3 and *Climate Zones* 4B and 4C, the *vertical fenestration* on the west, south, and east shall be shaded by permanent projections that have an area-weighted average *projection factor (PF)* of not less than 0.50 for the first story above grade and 0.25 for other above-grade stories. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Where different windows or glass doors have different *PF* values, each shall be evaluated separately, or an area-weighted *PF* value shall be calculated and used for all windows and glass doors. Horizontal projections shall extend over the full width of the glazing.

Exceptions: Permanent projections are not required for the following buildings and fenestrations:

1. Where *vertical fenestration* is located within 18 in. (450 mm) of the lot line.
2. Where equivalent shading of the *vertical fenestration* is provided by buildings, structures, geological formations, or permanent exterior projections that are not horizontal, as determined by sun-angle studies at the peak solar altitude on the summer solstice and three hours before and after the peak solar altitude on the summer solstice.
3. *Vertical fenestration* with automatically controlled shading devices capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
    a. Exterior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position.
    b. Interior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position and have a minimum solar reflectance of 0.50 for the surface facing *the fenestration.*
    c. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than four hours.
    d. Acceptance testing and commissioning shall be conducted as required by Chapter 10 (Section 10) to verify that *automatic* controls for shading devices respond to changes in illumination or radiation intensity.
4. *Vertical fenestration* with automatically controlled *dynamic glazing* capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
    a. *Dynamic glazing* shall have a lower labeled *SHGC* equal to or less than 0.12, lowest labeled visible transmittance (VT) no greater than 0.05, and highest labeled VT no less than 0.40.
    b. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than 4 hours.
    c. Acceptance testing and commissioning shall be conducted as required by Chapter 10 (Section 10) to verify that *automatic* controls for *dynamic glazing* respond to changes in illumination or radiation intensity.
5. Existing buildings undergoing alteration, repair, relocation, or a change of occupancy.

701.4.2.7 (7.4.2.7)SHGC of Vertical Fenestration For *SHGC* compliance, the methodology in ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception 2, is allowed, provided that the *SHGC* multipliers in Table 701.4.2.7 (7.4.2.7) of this standard are used. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Table 5.5.4.4.1; that table shall not apply. *Vertical fenestration* that is *north oriented* shall be allowed to have a maximum *SHGC* of 0.10 greater than that specified in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-1 through 5.5-8. When this provision is used, separate calculations shall be performed for these sections of the *building envelope,* and these values shall not be averaged with any others for compliance purposes.

TABLE 701.4.2.2 (TABLE 7.4.2.7)
SHGC MULTIPLIERS FOR PERMANENT PROJECTIONS

PF	SHGC MULTIPLIER (ALL OTHER ORIENTATIONS)	SHGC MULTIPLIER (NORTH-ORIENTED)
0 to 0.60	1.00	1.00
> 0.60 to 0.70	0.92	0.96
> 0.70 to 0.80	0.84	0.94
> 0.80 to 0.90	0.77	0.93
> 0.90 to 1.00	0.72	0.90

701.4.2.8 (7.4.2.8)Building Envelope Trade-Off Option The *building envelope* trade-off option in ANSI/ASHRAE/IES Standard 90.1, Section 5.6, shall not apply unless the procedure incorporates the modifications and additions to ANSI/ASHRAE/IES Standard 90.1 noted in Section 701.4.2 (7.4.2).

701.4.2.9 (7.4.2.9)Orientation The *vertical fenestration* shall comply with either (a) or (b):

a.$A_W \le (A_N + A_S)/4$ and $A_E \le (A_N + A_S)/4$

b.$A_W \times SHGC_W \le (A_N \times SHGC_C + A_s \times SHGC_c)/6$ and $A_E \times SHGC_E \le (A_N \times SHGC_C + A_s \times SHGC_c)/6$ where

***SHGC*$_x$ =**the *SHGC* for orientation *x* that complies with Section 701.4.2.7 (7.4.2.7).
***SHGC*$_C$ =**the *SHGC* criteria for each *climate zone* from Section 701.4.2.1 (7.4.2.1).
A*$_x$ =*fenestration area for orientation x.
***N* =**north (oriented less than 45 degrees of true north).
***S* =**south (oriented less than 45 degrees of true south).
***E* =**east (oriented less than or equal to 45 degrees of true east).
***W* =**west (oriented less than or equal to 45 degrees of true west).

Exceptions:

1.*Vertical fenestration* that complies with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception (3).

2.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).

3.Alterations and additions with no increase in *vertical fenestration area.*

4.Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section 701.4.2.1 (7.4.2.1).

5.Buildings in *Climate Zone* 8.

701.4.3 (7.4.3)Heating, Ventilating, and Air Conditioning The heating, ventilating, and air conditioning shall comply with ANSI/ASHRAE/IES Standard 90.1, Section (6), with the following modifications and additions.

701.4.3.2 (7.4.3.2)Ventilation Controls for Densely Occupied Spaces The requirements in this section supersede those in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3.8. *Demand control ventilation (DCV)* shall be provided for *densely occupied spaces* served by systems with one or more of the following:

a.An air-side economizer.

b.*Automatic* modulating control of the *outdoor air* dampers.

c.A design outdoor airflow greater than 1000 cfm (500 L/s).

Exceptions:

1.Systems with exhaust air energy recovery complying with Section 701.4.3.7 (7.4.3.7).

2.Systems with a design outdoor airflow less than 750 cfm (375 L/s).

3.*Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces.*

4.*Spaces* with one of the following occupancy categories as listed in ANSI/ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

The *DCV* system shall be designed to be in compliance with ASHRAE Standard 62.1, Section 6.2.7.1. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV.* All CO_2 sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

a.*Spaces* with CO_2 sensors or air-sampling probes leading to a central CO_2 monitoring station shall be provided with at least one sensor or probe for each 10, 000 ft^2(1000 m^2) of floor *space.* Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.

b.CO_2 sensors shall have a rated accuracy of ±50 ppm at 1000 ppm.

c.*Outdoor air* CO_2 concentrations shall be determined by one of the following:

1.*Outdoor air* CO_2 concentrations shall be dynamically measured using one or multiple CO_2 sensors. The CO_2 sensor locations shall be identified on the *construction documents.*

2.When documented statistical data on the local ambient CO_2 concentrations are available, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.

d.Occupant CO_2 generation rate assumptions shall be shown in the design documents.

701.4.3.3 (7.4.3.3)Duct Leakage Leakage tests shall comply with the requirements in ANSI/ASHRAE/ IES Standard 90.1, Section 6.4.4.2.2, with the following modification. Ductwork that is designed to operate at static pressures in excess of 2 in. of water (500 Pa), and all ductwork located outdoors, shall be leak-tested according to industry-accepted test procedures.

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01.4.3.4 (7.4.3.4)Economizers Systems shall include economizers meeting the requirements in ANSI/ ASHRAE/IES Standard 90.1, Section 6.5.1, except as modified by the following:

a.The minimum size requirements for economizers for comfort cooling and for computer rooms are defined in Table 701.4.3.4 (7.4.3.4) and supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.5.1-1 and 6.5.1-2.

b.Rooftop units with a capacity of less than 54, 000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling.* Units with a capacity equal to or greater than 54, 000 Btu/h (16 kW) shall comply with the staging requirements defined in ANSI/ ASHRAE/IES Standard 90.1, Section 6.5.3.1

c.For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume [VAV]* systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

All the exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, shall apply except as modified by the following:

a.Where the alternate renewable approach defined in Section 701.4.1.1.2 (7.4.1.1.2) is used, ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, Exception (10), shall be permitted to eliminate the economizer requirement, provided the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-2, are applied to the efficiency requirements required by Section 701.4.1.1.2 (7.4.1.1.2). If the standard renewable approach is chosen as defined in Section 701.4.1.1.1 (7.4.1.1.1) then the requirements in ANSI/ ASHRAE/IES Standard 90.1, Table 6.5.1-3, shall be applied to the efficiency requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.8.1-1 through 6.8.1-11.

b.For water-cooled units with a capacity less than 54, 000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat-pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat-rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

701.4.3.9 (7.4.3.9)Duct Insulation Duct insulation shall comply with the minimum requirements in Normative Appendix A, Tables A-2 and A-3. These requirements supersede the requirements in ANSI/ ASHRAE/IES Standard 90.1, Table 6.8.2.

701.4.4 (7.4.4)Service Water Heating The *service water heating* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 7, with the following modifications and additions.

701.4.4.2 (7.4.4.2)Insulation for Spa Pools Pools heated to more than 90°F (32°C) shall have side and bottom surfaces insulated on the exterior with a minimum insulation value of R-12 (R-2.1).

701.4.5 (7.4.5)Power The power shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 8.

701.4.6 (7.4.6)Lighting The lighting shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 9, with the following modifications and additions.

701.4.6.1. (7.4.6.1)Lighting Power Allowance

701.4.6.1.1 (7.4.6.1.1)Interior Lighting Power Densities (LPDs) The interior *lighting power allowance* shall be determined using ANSI/ ASHRAE/IES Standard 90.1, either Section 9.5 or 9.6, with the following modifications:

a.For those areas where the Building Area Method is used, the LPD from ANSI/ ASHRAE/IES Standard 90.1, Table 9.5.1, shall be replaced with the corresponding LPD in Table 701.4.6.1A (7.4.6.1A).

b.For those areas where the Space-by-Space Method is used, the LPD from ANSI/ ASHRAE/IES Standard 90.1, Table 9.6.1, shall be replaced with the corresponding LPD in Table 701.4.6.1B (7.4.6.1B).

c.Room geometry adjustment when using the Space-by-Space Method: ANSI/ASHRAE/ IES Standard 90.1, Section 9.6.4, shall be replaced with the following. For corridor/transition *spaces* less than 8 ft (2.4 m) wide, or individual *spaces* where room cavity ratio (RCR) calculated for the empty room is documented to be greater than the RCR threshold for that *space* type shown in Table 701.4.6.1B (7.4.6.1B), the allowed LPD shall be 1.2 times the LPD in Table 701.4.6.1B (7.4.6.1B). RCR shall be calculated as described in ANSI/ ASHRAE/IES Standard 90.1, Section 9.6.4.

d.Additional lighting power when using the Space-by-Space Method: For those areas where the Space-by-Space Method is used, the additional increase in the interior lighting power allowed by ANSI/ASHRAE/IES Standard 90.1, Section 9.6.2, for specific lighting functions shall be replaced by the requirements and allowances of this section. Additional power shall be allowed only if the specified lighting is installed and automatically controlled separately from the general lighting and is designed and installed 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. An increase in the interior *lighting power allowance* is permitted in the following cases:

TABLE 701.4.6.1A (TABLE 7.4.6.1A)
LIGHTING POWER DENSITIES USING THE BUILDING AREA METHOD

BUILDING AREA TYPE[a]	LPD, W/ft^2	LPD, W/m^2
Automotive facility	0.64	6.9
Convention center	0.51	5.5
Courthouse	0.74	8.0
Dining: Bar lounge/leisure	0.69	7.4
Dining: Cafeteria/fast food	0.66	7.1
Dining: Family	0.61	6.6
Dormitory	0.52	5.6
Exercise center	0.61	6.6
Fire station	0.50	5.4
Gymnasium	0.67	7.2
Health care clinic	0.68	7.3
Hospital	0.86	9.3
Hotel/Motel	0.70	7.5
Library	0.72	7.8
Manufacturing facility	0.60	6.5
Motion picture theater	0.62	6.7
Multifamily	0.49	5.3
Museum	0.68	7.3
Office	0.69	7.4
Parking garage	0.12	1.3
Penitentiary	0.67	7.2
Performing arts theater	0.85	9.1
Police station	0.68	7.3
Post office	0.62	6.7
Religious facility	0.70	7.5
Retail	0.91	9.8
School/university	0.67	7.2
Sports arena	0.76	8.2

BUILDING AREA TYPE[a]	LPD, W/ft^2	LPD, W/m^2
Town hall	0.72	7.8
Transportation	0.51	5.5
Warehouse	0.41	4.4
Workshop	0.83	8.9

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.

1.For *spaces* in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 0.5W/ft^2(5.4 W/m^2) of such *spaces.*

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

Additional interior *lighting power allowance* = 750 W
+ [Retail Area 1 x 0.40 W/ft^2(4.3 W/m^2)]
+ [Retail Area 2 x 0.40 W/ft^2(4.3 W/m^2)]
+ [Retail Area 3 x 1.00 W/ft^2(10.8 W/m^2)]
+ [Retail Area 4 x 1.50 W/ft^2(16.1 W/m^2)]
where

Retail Area 1=the floor area for all products not listed in Retail Areas 2, 3, or 4.
Retail Area 2 =the floor area used for the sale of vehicles, sporting goods, and small *electronics.*
Retail Area 3 =the floor area used for the sale of furniture, clothing, cosmetics, and artwork.
Retail Area 4 =the floor area used for the sale of jewelry, crystal, and china.
Exception: Other merchandise categories included in Retail Areas 2 through 4 where the *authority having jurisdiction* has approved the documented need for additional lighting power based on visual inspection, contrast, or other critical display.

e.Any of the control factors from ANSI/ ASHRAE/IES Standard 90.1, Table 9.6.3, shall be permitted to be applied, provided that the corresponding control method is not required by ANSI/ASHRAE/ICC/USGBC/ IES Standard 189.1.

f.An additional *lighting power allowance* shall be credited for *institutional tuning* of dimmable lighting systems that meet all of the following requirements:

1.*Institutional tuning* controls shall be accessible only to authorized personnel.

2.*Construction documents* shall state that maximum light output or power of controlled lighting shall be reduced by at least 15% from full output.

3.The maximum light output or power of the controlled lighting shall be measured without *institutional tuning* and with *institutional tuning* to verify reduction of light output or power by at least 15% when tuned. In daylighted areas these measurements shall be conducted at night.

For controlled lighting in daylighted areas, the additional *lighting power allowance* shall be 0.05 times the controlled lighting power. In nondaylighted areas, the additional *lighting power allowance* shall be 0.10 times the controlled lighting power.

TABLE 701.4.6.1B (TABLE 7.4.6.1B)
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR) THRESHOLDS USING THE SPACE-BY-SPACE METHOD

Informative Note: This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

COMMON SPACE TYPES[a]	LPD, W/ft^2	LPD, W/m^2	RCR THRESHOLD
Atrium			
< 20 ft (6.1m) in height	0.023/ft total height	0.81/m total height	NA
≥ 20 ft (6.1m) and < 40 ft (12.2 m) in height	0.023/ft total height	0.81/m total height	NA
> 40 ft (12.2 m) in height	0.30 + 0.015/ft total height	3.2 + 0.53/m total height	NA
Audience Seating Area			
Auditorium	0.67	7.2	6
Convention center	0.65	7.0	4

Gymnasium	0.43	4.6	6
Motion picture theater	0.64	6.9	4
Penitentiary	0.44	4.7	4
Performing arts theater	1.34	14.4	8
Religious building	0.98	10.5	4
Sports arena	0.42	4.5	4
All other audience *seating* areas	0.40	4.3	4
Banking Activity Area	0.79	8.5	6
Breakroom (see Lounge/Breakroom)			
Classroom/Lecture Hall/Training Room			
Penitentiary	1.06	11.4	4
All other *classrooms/lecture* halls/training rooms	0.74	8.0	4
Conference/Meeting/Multipurpose Room	0.93	10.0	6
Confinement Cells	0.52	5.6	6
Copy/Print Room	0.50	5.4	6
Corridor[b]			
Facility for the visually impaired (and not used primarily by the staff)[c]	0.81	8.7	width < 8 ft (2.4 m)
Hospital	0.81	8.7	width < 8 ft (2.4 m)
Manufacturing facility	0.28	3.0	width < 8 ft (2.4 m)
All other corridors	0.58	6.2	width < 8 ft (2.4 m)
Courtroom	0.98	10.5	6
Computer Room	1.16	12.5	4
Dining Area			
Penitentiary	0.72	7.8	6
Facility for the visually impaired (and not used primarily by staff)[c]	1.48	15.9	4
Bar/lounge or leisure dining	0.62	6.7	4
Cafeteria or fast food dining	0.53	5.7	4
Family dining	0.54	5.8	4
All other dining areas	0.53	5.7	4
Electrical/Mechanical Room[g]	0.39	4.2	6
Emergency Vehicle Garage	0.53	5.7	4
Food Preparation Area	0.92	9.9	6
Guest Room	0.75	8.1	6
Laboratory			
In or as a *classroom*	1.04	11.2	6
All other laboratories	1.24	13.3	6
Laundry/Washing Area	0.43	4.6	4
Loading Dock, Interior	0.51	5.5	6
Lobby			
Facility for the visually impaired (and not used primarily by the staff)[c]	1.30	14.0	4
Elevator	0.52	5.6	6
Hotel	0.68	7.3	4
Motion picture theater	0.38	4.1	4
Performing arts theater	0.82	8.8	6
All other lobbies	0.86	9.3	4
Locker Room	0.45	4.8	6
Lounge/Breakroom			
Healthcare facility	0.53	5.7	6
All other lounges/breakrooms	0.44	4.7	4
Office			
Enclosed and ≤ 250 ft^2 (23 m^2)	0.85	9.1	8

Enclosed and > 250 ft^2 (23 m^2)	0.85	9.1	8
Open plan	0.78	8.4	4
Parking Area, Interior	0.11	1.2	4
Pharmacy Area	1.23	13.2	6
Restroom			
Facility for the visually impaired (and not used primarily by the staff)[c]	0 81	8 7	8
All other restrooms	0.75	8.1	8
Sales Area[d]	1.06	11.4	6
Seating Area, General	0.38	4.1	4
Stairway	The *space* containing the stairway shall determine the LPD requirements for the stairway.		
Stairwell	0.50	5.4	10
Storage Room			
< 50 ft^2 (4.6m^2)	0.86	9.3	6
≥ 50 ft^2 (4.6m^2) and ≤ 1000 ft^2 (93 m^2)	0.43	4.6	6
All other storage rooms	0.43	4.6	6
Vehicular Maintenance Area	0.53	5.7	4
Workshop	1.09	11.7	6
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD, W/ft^2**	**LPD, W/m^2**	**RCR THRESHOLD**
Facility for the Visually Impaired[c]			
Chapel (used primarily by residents)	0.89	8.9	4
Recreation room/common living room (and not used primarily by staff)	1.53	15.3	6
Automotive (see Vehicular Maintenance Area)			
Convention Center—Exhibit Space	0.69	7.43	4
Dormitory—Living Quarters	0.46	4.95	8
Fire Station—Sleeping Quarters	0.19	2.05	6
Gymnasium/Fitness Center			
Exercise area	0.50	5.4	4
Playing area	0.75	8.1	4
Healthcare Facility			
Exam/treatment room	1.16	12.5	8
Imaging room	0.98	10.5	6
Medical supply room	0.54	5.8	6
Nursery	0.94	10.1	6
Nurse's station	0.75	8.1	6
Operating room	1.87	20.1	6
Patient room	0.45	4.8	6
Physical therapy room	0.85	9.1	6
Recovery room	0.89	9.6	6
Library			
Reading area	0.77	8.3	4
Stacks	1.08	11.6	4
Manufacturing Facility			
Detailed manufacturing area	0.86	9.3	4
Equipment room	0.61	6.6	6
Extra high bay area (> 50 ft [15.2 m] floor-to-ceiling height)	0.73	7.9	4
High bay area (25 ft [7.6 m] to 50 ft [15.2 m] floor-to-ceiling height)	0.58	6.2	4
Low bay area (< 25 ft [7.6 m] floor-to-ceiling height)	0.61	6.6	4
Museum			
General exhibition area	0.61	6.6	6
Restoration room	0.77	8.3	6
Performing Arts Theater—Dressing Room	0.35	3.8	6

Post Office—Sorting Area	0.66	7.1	4
Religious Buildings			
Fellowship hall	0.42	4.5	4
Worship/pulpit/choir area	0.98	10.5	4
Retail Facilities			
Dressing/fitting room	0.49	5.3	8
Mall concourse	0.79	8.5	4
Sports Arena—Playing Area[h]			
Class I facility	2.26	24.3	4
Class II facility	1.45	15.6	4
Class III facility	1.08	11.6	4
Class IV facility	0.72	7.8	4
Transportation Facility			
Baggage/carousel area	0.40	4.3	4
Airport concourse	0.22	2.4	4
Terminal ticket counter	0.48	5.2	4
Warehouse—Storage Area			
Medium-to-bulky, palletized items	0.27	2.9	4
Smaller, hand-carried items[e]	0.65	7.0	6

1. a.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. b.In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c) [7.4.6.1.1(c)].
3. c.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. d.For accent lighting, see Section 701.4.6.1.1(d) [7.4.6.1.1(d)].
5. e.Sometimes referred to as a "picking area."
6. f.Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
7. g.Electrical/mechanical rooms. An additional 0.50 W/ft^2(5.4 W/m^2) shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft^2(4.2 W/m^2). The additional 0.50 W/ft^2(5.4 W/m^2) allowance shall not be used for any other purpose.
8. h.Class of play as defined by IES RP-6.

701.4.6.1.2 (7.4.6.1.2)Exterior LPDs The exterior lighting of the project shall meet the requirements of the adopted City of Tempe Energy Code (IECC 2018) and the city site lighting requirements.

701.4.6.2 (7.4.6.2)Occupancy Sensor Controls with Multilevel Switching or Dimming The lighting in commercial and industrial storage stack areas shall be controlled by an occupant sensor with multilevel switching or dimming system that reduces lighting power a minimum of 50% within 20 minutes of all occupants leaving the stack area.

Exception: Storage stack areas illuminated by high-intensity discharge (HID) lighting with an LPD of 0.8 W/ft^2(8.6 W/m^2) or less.

701.4.7 (7.4.7)Other Equipment The other equipment shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 10, with the following modifications and additions.

701.4.7.2 (7.4.7.2)Supermarket Heat Recovery Supermarkets with a floor area of 25, 000 ft^2(2500 m^2) or greater shall recover waste heat from the condenser heat rejection on *permanently installed* refrigeration equipment meeting one of the following criteria:

a.Twenty-five percent (25%) of the refrigeration system full-load total heat rejection.

b.Eighty percent (80%) of the *space* heat, *service water heating,* and dehumidification reheat.

If a recovery system is used that is installed in the refrigeration system, the system shall not increase the saturated condensing temperature at design conditions by more than 5°F (3°C) and shall not impair other head pressure control/energy reduction strategies.

701.4.7.3 (7.4.7.3)ENERGY STAR Equipment All *building projects* shall comply with the requirements in Section 701.4.7.3.1 (7.4.7.3.1) and all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 (7.4.1.1.2) shall also comply with Section 701.4.7.3.2 (7.4.7.3.2).

701.4.7.3.1 (7.4.7.3.1)ENERGY STAR Requirements for Equipment not Covered by Federal Appliance Efficiency Regulations (All Building Projects) The following equipment within the

scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy:

a.Appliances:

1.Room air cleaners: ENERGY STAR Program Requirements for Room Air Cleaners.

2.Water coolers: ENERGY STAR Program Requirements for Water Coolers.

b.Heating and Cooling:

1.Programmable thermostats: ENERGY STAR Program Requirements for Programmable Thermostats.

2.Ventilating fans: ENERGY STAR Program Requirements for *Residential* Ventilating Fans.

c.Electronics:

1.Cordless phones: ENERGY STAR Program Requirements for Telephony.

2.Audio and video: ENERGY STAR Program Requirements for Audio and Video.

3.Televisions: ENERGY STAR Program Requirements for Televisions.

4.Set-top boxes: ENERGY STAR Program Requirements for Set-Top Boxes.

d.Office Equipment:

1.Computers: ENERGY STAR Program Requirements for Computers.

2.Copiers: ENERGY STAR Program Requirements for Imaging Equipment.

3.Fax machines: ENERGY STAR Program Requirements for Imaging Equipment.

4.Laptops: ENERGY STAR Program Requirements for Computers.

5.Mailing machines: ENERGY STAR Program Requirements for Imaging Equipment.

6.Monitors: ENERGY STAR Program Requirements for Displays.

7.Multifunction devices (printer/fax/ scanner): Program Requirements for Imaging Equipment.

8.Printers: ENERGY STAR Program Requirements for Imaging Equipment.

9.Scanners: ENERGY STAR Program Requirements for Imaging Equipment.

10.Computer servers: ENERGY Star Program Requirements for Computer Servers.

e.Lighting:

1.Integral LED lamps: ENERGY STAR Program Requirements for Integral LED Lamps.

f.Commercial Food Service:

1.Commercial fryers: ENERGY STAR Program Requirements for Commercial Fryers.

2.Commercial hot food holding cabinets: ENERGY STAR Program Requirements for Hot Food Holding Cabinets.

3.Commercial steam cookers: ENERGY STAR Program Requirements for Commercial Steam Cookers [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].

4.Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers.

5.Commercial griddles: ENERGY STAR Program Requirements for Commercial Griddles.

6.Commercial ovens: ENERGY STAR Program Requirements for Commercial Ovens [see also water efficiency requirements in Section 601.3.2.5 (6.3.2.5)].

Exception: Products with minimum efficiencies addressed in the Energy Policy Act (EPAct) and the Energy Independence and Security Act (EISA) when complying with Section 701.4.1.1.2 (7.4.1.1.2).

701.4.7.4 (7.4.7.4)Programmable Thermostats *Residential* programmable thermostats shall meet the requirements of NEMA Standards Publication DC 3, Annex A, "Energy-Efficiency Requirements for Programmable Thermostats."

~~**701.4.7.5 (7.4.7.5)Refrigerated Display Cases** All open refrigerated display cases shall be covered by using field-installed strips, curtains, or doors.~~

701.4.8 (7.4.8)Energy Cost Budget The Energy Cost Budget option in ANSI/ASHRAE/IES Standard 90.1, Section 11, shall not be used.

701.5 (7.5) Performance Option

701.5.1 (7.5.1)Annual Energy Cost Energy performance modeling. Performance-based designs shall demonstrate a zEPI of not more than 44 as determined in accordance with Equation 6-1.

zEPI = 52 × (Proposed building performance/Baseline building performance) (Equation 6-1)

where:

Proposed Building Performance = The proposed building performance in source kBtu for the proposed design of the building and its site calculated in accordance with Section 602.2.1.

Baseline Building Performance = The baseline building performance in source kBtu for a baseline building and its site calculated in accordance with Section 602.2.1.
52 = a fixed value representing the performance of a baseline building designed to comply with ASHRAE Standard 90.1-2013.

701.5.2 (7.5.2)Annual Carbon Dioxide Equivalent (CO_2e) The *proposed design* shall have an annual *CO_2e* equal to or less than the annual *CO_2e* of the *base-line building design* To determine the annual *CO_2e* for each energy source in the *baseline building design* and *proposed design,* the energy consumption shall be multiplied by the *CO_2e* emission factors from Table 701.5.2B (7.5.2B).

TABLE 701.5.2B (TABLE 7.5.2B)
CO_2e EMISSION FACTORS

BUILDING PROJECT ENERGY SOURCE	CO_2e, lb/MWh	CO_2e, kg/MWh
Grid-delivered electricity and other fuels not specified in this table	1348	612
LPG or propane	601	273
Fuel oil (residual)	685	311
Fuel oil (distillate)	663	301
Coal	820	372
Gasoline	681	309
Natural gas	509	231
District chilled water	323	146
District steam	855	388
District hot water	807	366

The values in this table represent national averages for the United States and include both direct and indirect emissions.