

ANSI/ASHRAE/USGBC/IES Addenda g, i, m, p, q, r, u, v and w to
ANSI/ASHRAE/USGBC/IES
Standard 189.1-2009

Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

Approved by the ASHRAE Standards Committee on September 27, 2011; by the ASHRAE Board of Directors on November 1, 2011; by the USGBC Board of Directors on October 28, 2011; by the IES Board of Directors on October 28, 2011; and by the American National Standards Institute on November 2, 2011.

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FOREWORD

In sections 5, 7 and 8, Addendum g updates the references to ASHRAE Standards 62.1, 90.1, and 55 to the newly published 2010 versions. In addition, this proposal updates new and revised ENERGY STAR program requirements.

The changes in Section 7.4.6.6 bring the requirements in Standard 189.1 to a comparable level of stringency as Standard 90.1-2010.

In addition, changes to Section 9 clarify the intent of requirements included for construction waste management and material harvesting/extraction.

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

Addendum g to Standard 189.1-2009

Modify Section 5.3.3 as follows:

5.3.3 Reduction of Light Pollution

5.3.3.1 General. Exterior lighting systems shall comply with Section 9 of ANSI/ASHRAE/IESNA Standard 90.1 with Addendum i, with the following modifications to the *lighting power allowances* in Table 9.4.6, and the requirement of and with Sections 5.3.3.2 and 5.3.3.3 of this standard.

- a. For *LZO*: there shall be no Base Site allowance and no Tradable Surface allowances.
- b. For *LZO* (Non-Tradable Surfaces): a single luminaire of 60 watts or less may be installed for each roadway/parking entry, trail head, and toilet facility, or other locations approved by the *AHJ*.

5.3.3.2 Backlight and Glare

- a. All building-mounted luminaires located less than two mounting heights from any property line shall meet the maximum allowable Glare Ratings in Table 5.3.3.2B.
- b. All other luminaries shall meet the maximum allowable Backlight and Glare Ratings in Table 5.3.3.2A.

5.3.3.3 Uplight: All exterior lighting shall meet one of the following Uplight requirements:

- a. Exterior luminaries shall meet the maximum allowable Uplight Ratings of Table 5.3.3.2A or
- b. Exterior lighting shall meet the Uplight requirements of Table 5.3.3.3.

Exceptions:

1. Lighting in *lighting zones* 3 and 4, solely for uplighting structures, building facades, or landscaping.
2. Lighting in *lighting zones* 1 and 2, solely for uplighting structures, building facades, or landscaping provided the applicable lighting power densities do not exceed 50% of the *lighting power allowances* in ANSI/ASHRAE/IESNA Standard 90.1, Table 9.4.3B, with Addendum i Table 9.4.6.

Delete Section 7.4.2.7 and renumber subsequent sections in 7.4.2

~~**7.4.2.7 Vestibules.** For vestibules, the exceptions to Section 5.4.3.4 of ANSI/ASHRAE/IESNA Standard 90.1 are allowed provided that *climate zone* 4 is deleted from exception (e) to Section 5.4.3.4 of ANSI/ASHRAE/IESNA Standard 90.1 and that *climate zone* 4 is added to exception (f) to Section 5.4.3.4 of ANSI/ASHRAE/IESNA Standard 90.1.~~

Modify Section 7.4.6 as follows: (change numbering of sub-clauses as needed)

7.4.6 Lighting. The lighting shall comply with Section 9 of ANSI/ASHRAE/IESNA Standard 90.1 as modified by Addendum i and the following modifications and additions.

7.4.6.2 Occupancy Sensor Controls. Offices 250 ft² (25 m²) or smaller; *classrooms* of any size; lecture, training, or vocational rooms of less than 1000 ft² (100 m²); multipurpose rooms of less than 1000 ft² (100 m²); conference rooms and meeting rooms less than 1000 ft² (100 m²); and meeting centers shall be equipped with occupant sensor(s) to automatically turn lighting OFF within 30 minutes of all occupants leaving a space and allow “manual OFF” control. In addition, all occupancy sensor controls shall be either “manual ON” or bi-level “automatic ON” programmed to a low light level combined with multi-level circuitry and “manual ON” switching for higher light levels. Where such occupancy sensors are utilized within a daylight area and daylighting controls are utilized, the occupancy sensors shall work in conjunction with the daylighting controls complying with Section 7.4.6.5.

7.4.6.5 Automatic Controls for Lighting in Daylight Zones. Lighting in all *daylight zones*, including *daylight zones under skylights* and *daylight zones adjacent to vertical fenestration*, where the combined *daylight zone* per enclosed space is greater than 250 ft² (25 m²), shall be provided with controls that automatically reduce lighting power in response to available daylight by either:

- a. ~~a. Continuous daylight dimming, or~~
- b. ~~b. A combination of stepped switching and daylight-sensing automatic controls, which are capable of incrementally reducing the light level in steps automatically and turning the lights off automatically.~~

Exceptions:

1. ~~Window display and exhibition lighting.~~
2. ~~Conference rooms greater than 250 ft² (25 m²) that have a lighting control system with at least four scene options.~~

3. ~~Lighting in conference rooms that is dimmable and controlled by dimming controls that are located within the space and accessible to the space occupants.~~
4. ~~Saunas, steam rooms, and spaces containing swimming pools or spa pools.~~
5. ~~Spaces where medical procedures are performed.~~
6. ~~Spaces within dwelling units.~~
7. ~~Spaces within hotel and motel guest rooms and suites.~~
8. ~~Daylight zones where the height of existing adjacent structures above the window is at least twice the distance between the window and adjacent structures, measured from the top of the glazing.~~

7.4.6.6 “Manual ON” Occupancy Sensors. Occupancy sensors shall either have “manual ON”, “automatic OFF” controls 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:

Exception:

1. ~~Occupancy sensor controls required in Section 7.4.6.3,~~
2. ~~public corridors and stairwells,~~
3. ~~restrooms,~~
4. ~~primary building entrance areas and lobbies, and~~
5. ~~areas where manual-on operation would endanger the safety or security of the room or building occupant(s).~~

7.4.6.7 Controls for Outdoor Lighting. ~~All outdoor lighting controls shall comply with Section 9 of ANSI/ASHRAE/IESNA Standard 90.1 with the following modifications and additions. For lighting of building facades, parking lots, garages, canopies (sales and non-sales), and all outdoor sales areas, automatic controls shall be installed to reduce the sum of all lighting power (in watts) by a minimum of 50% one hour after normal business closing and to turn off outdoor lighting within 30 minutes after sunrise.~~

Exceptions:

1. ~~Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting.~~
2. ~~Lighting that is controlled by a motion sensor and photocontrol.~~
3. ~~Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously.~~
4. ~~Temporary outdoor lighting.~~
5. ~~Externally illuminated signs and signs that are internally illuminated or have integral lamps.~~

Revise the following in section 7.4.7

7.4.7 Other Equipment. The other equipment shall comply with Section 10 of ANSI/ASHRAE/IESNA Standard 90.1 with the following modifications and additions.

7.4.7.1 Electric Motors. Motors shall comply with the minimum requirements in Table C-13 in Normative Appendix C. These requirements supersede the requirements

in Section 10.4.1 and Table 10.8 of ANSI/ASHRAE/IESNA Standard 90.1.

7.4.7.2 Supermarket Heat Recovery. Supermarkets with a floor area of 25,000 ft² (2500 m²) or greater shall recover waste heat from the condenser heat rejection on permanently installed refrigeration equipment meeting one of the following criteria:

1. 25% of the refrigeration system full load total heat rejection.
2. 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.

7.4.7.3 ENERGY STAR Equipment. 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. Clothes washers: ENERGY STAR Program Requirements for Clothes Washers (see also the water efficiency requirements in Section 6.3.2.2)
2. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers
3. Dishwashers: ENERGY STAR Program Requirements Product Specifications for Residential Dishwashers (see also the water efficiency requirements in Section 6.3.2.2)
4. Refrigerators and freezers: ENERGY STAR Program Requirements for Refrigerators and Freezers
5. Room air conditioners: ENERGY STAR Program Requirements and Criteria for Room Air Conditioners (see also the energy efficiency requirements in Section 7.4.1)
6. Room air cleaners: ENERGY STAR Program Requirements for Room Air Cleaners
7. Water coolers: ENERGY STAR Program Requirements for ~~Bottled~~ Water Coolers

b. Heating and Cooling

1. Residential air-source heat pumps: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners (see also the energy efficiency requirements in Section 7.4.1)
2. Residential boilers: ENERGY STAR Program Requirements for Boilers (see also the energy efficiency requirements in Section 7.4.1)
3. Residential central air conditioners: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners (see also the energy efficiency requirements in Section 7.4.1)

4. Residential ceiling fans: ENERGY STAR Program Requirements for Residential Ceiling Fans
 5. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers
 6. Programmable thermostats: ENERGY STAR Program Requirements for Programmable Thermostats
 7. Ventilating fans: ENERGY STAR Program Requirements for Residential Ventilating Fans
 8. Residential Warm Air Furnaces: ENERGY STAR Program Requirements for Warm Air Furnaces
 9. Residential Geothermal Heat Pumps: ENERGY STAR Program Requirements for Geothermal Heat Pumps
- c. Electronics
1. Cordless phones: ENERGY STAR Program Requirements for Telephony
 2. ~~Combination units (TV/VCR/DVD): ENERGY STAR Program Requirements for Televisions~~
 3. 2. Audio and Video: ENERGY STAR Program Requirements for Consumer Audio and DVD Products Video
 4. 3. Televisions: ENERGY STAR Program Requirements for Televisions
 5. 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 ~~Computer Monitors 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. Water Heaters: ENERGY STAR Program Requirements for Residential Water Heaters
- f. Lighting
1. Compact fluorescent light bulbs (CFLs): ENERGY STAR Program Requirements for CFLs
 2. Residential light fixtures: ENERGY STAR Program Requirements for Residential Light Fixtures
 3. Integral LED Lamps: ENERGY STAR program Requirements for Integral LED Lamps
- g. 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 ~~solid door~~ refrigerators and freezers: ENERGY STAR Program Requirements for ~~Solid Door~~ Commercial Refrigerators and Freezers
 4. Commercial steam cookers: ENERGY STAR Program Requirements for Commercial Steam Cookers (see also water efficiency requirements in Section 6.4.2.2)
 5. Commercial ice machines: ENERGY STAR Program Requirements for Commercial Ice Machines
 6. Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers
 7. Commercial Griddles: ENERGY STAR program Requirements for Commercial Griddles
 8. Commercial Ovens: ENERGY STAR program Requirements for Commercial Ovens
- h. Other Products
1. Battery charging systems: ENERGY STAR Program Requirements for Products with Battery Charger Systems (BCSs)
 2. External power adapters: ENERGY STAR Program Requirements for Single-Voltage AC-DC and AC-AC Power Supplies
 3. Vending machines: ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines
- Exception:** Products with minimum efficiencies addressed in the Energy Policy Act (EPA) and the Energy Independence and Security Act (EISA) when complying with Section 7.4.3.1a.
- 7.4.7.4 Commercial Refrigerators, Freezers, and Clothes Washers**
- a. Commercial refrigerators and freezers shall comply with the minimum efficiencies in Table C-14 in Normative Appendix C. Open refrigerated display cases not covered by strips or curtains are prohibited. Lighting loads, including all power supplies or ballasts, for commercial reach-in refrigerator/freezer display cases shall not exceed 42 watts per door for case doors up to 5 ft (1.5 m) in height and 46 watts per door for case doors greater than 5 ft (1.5 m) in height.

- b. Commercial clothes washers shall comply with the minimum efficiencies in Table C-15 in Normative Appendix C.

Modify Section 8.3.1 and 8.3.2 as follows:

8.3.1.3 Filtration and Air Cleaner Requirements

a. Particulate Matter

1. **Wetted Surfaces.** ~~The p~~ Particulate matter filters or air cleaners provided upstream of wetted surfaces in accordance with Section 5.8 of ANSI/ASHRAE Standard 62.1 shall have a MERV of not less than 8 and shall comply with and be provided where required in Section 5.9 of ANSI/ASHRAE Standard 62.1.
 2. **Particulate Matter Smaller than 10 Micrometers (PM10).** Particulate matter filters or air cleaners provided to reduce PM10 in outdoor intake in accordance with 6.2.1.1 of ANSI/ASHRAE Standard 62.1 shall have a MERV of not less than 8.
 3. **Particulate Matter Smaller than 2.5 Micrometers (PM2.5).** ~~In addition to Section 6.2.1.12 of ANSI/ASHRAE Standard 62.1, when the building is located in an area that is designated "non-attainment" with the National Ambient Air Quality Standards for PM_{2.5} as determined by the AHJ, (in the US by the USEPA), particle filters or air-cleaning devices shall be provided to clean outdoor air prior to its introduction to occupied spaces having~~ Particulate matter filters or air cleaners provided to reduce PM2.5 in outdoor intake air in accordance with Section 6.2.1.2 of ANSI/ASHRAE Standard 62.1 shall have a MERV of not less than 13 when rated in accordance with ANSI/ASHRAE Standard 52.2.
- b. **Ozone.** In addition to Section 6.2.1.23 of ANSI/ASHRAE Standard 62.1, when the building is located in an area that is designated "non-attainment" with the National Ambient Air Quality Standards for ozone as determined by the AHJ, air-cleaning devices having a removal efficiency of no less than the efficiency specified in Section 6.2.1.23 of ANSI/ASHRAE Standard 62.1 shall be provided to clean outdoor air prior to its introduction to occupied spaces.
- c. **Bypass Pathways.** All filter frames, air cleaner racks, access doors, and air cleaner cartridges shall be sealed.

8.3.1.4 Environmental Tobacco Smoke

- a. Smoking shall not be allowed inside the building. Signage stating such shall be posted within 10 ft (3 m) of each building entrance.
- b. Any exterior designated smoking areas shall be located a minimum of 25 ft (7.5 m) away from *building entrances, outdoor air intakes, and operable windows.*
- e. ~~Section 6.2.9 of ANSI/ASHRAE Standard 62.1 shall not apply.~~

8.3.2 Thermal Environmental Conditions for Human Occupancy. The building shall be designed in compliance with ANSI/ASHRAE Standard 55, Sections 6.1, "Design," and 6.2, "Documentation," ~~of ANSI/ASHRAE Standard 55."~~

Spaces with special requirements for processes, activities, or contents that require a thermal environment outside that which humans find thermally acceptable, such as food storage, natatoriums, shower rooms, saunas, and drying rooms.

Modify Section 9.3 as follows:

9.3 Mandatory Provisions

9.3.1 Construction Waste Management

9.3.1.1 Diversion. A minimum of 50% of nonhazardous construction and demolition waste material generated prior to the issuance of the final certificate of occupancy shall be diverted from disposal in landfills and incinerators by recycling and/or reuse. Reuse includes donation of materials to charitable organizations, salvage of existing materials onsite, and packaging materials returned to the manufacturer, shipper, or other source that will reuse the packaging in future shipments. Excavated soil and land-clearing debris shall not be included in the calculation. Calculations are allowed to be done by either weight or volume, but shall be consistent throughout. Specific area(s) on the construction *site* shall be designated for collection of recyclable and reusable materials. Off-site storage and sorting of materials shall be allowed. Diversion efforts shall be tracked throughout the construction process.

9.3.1.2 Total Waste. For new *building projects* on *sites* with less than 5% existing buildings, structures or *hardscape*, the total amount of construction waste generated prior to the issuance of the final certificate of occupancy on the project shall not exceed 42 yd³ or 12,000 lbs per 10,000 ft² (35 m³ or 6000 kg per 1000 m²) of new building floor area. This shall apply to all waste whether diverted, landfilled, incinerated, or otherwise disposed of. Excavated soil and land-clearing debris shall not be included in the calculation. The amount of waste shall be tracked throughout the construction process.

9.3.2 Extracting, Harvesting, and/or Manufacturing. This section applies to all materials, products, and/or assemblies installed prior to the issuance of the final certificate of occupancy.

Materials shall be harvested and/or extracted and products and/or assemblies shall be manufactured according to the laws and regulations of the country of origin.

Wood products in the project, other than recovered or reused wood, shall not contain wood from endangered wood species unless the trade of such wood conforms with the requirements of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Modify Section 11 as follows:

Section numbers indicate where the reference occurs in this document.

Reference	Title	Section
United States Environmental Protection Agency (USEPA)		
Ariel Rios Building		
1200 Pennsylvania Avenue, N.W.		
Washington, DC 20460		
1-919-541-0800; www.epa.gov		
ENERGY STAR® 1-888-782-7937		
WaterSense 1-866-987-7367 and 1-202-564-2660		
Clean Air Act of 1970 and as amended in 1990	Clean Air Act	9.5.1.2
Code of Federal Regulations, Title 40 Part 50 (40 CFR 50), as amended July 1, 2004	National Primary and Secondary Ambient Air Quality Standards	8.3.1.3, 9.5.1.2
January 21, 2005	NPDES General Permit for Stormwater Discharges From Construction Activities	10.3.1.3
Version 4.0, July 20, 2007 Version 5.0, July 1, 2009	ENERGY STAR Computer Memorandum of Understanding ENERGY STAR Program Requirements for Computers	7.4.7
Version 1.0 April 1, 2007 Version 1.1, July 1, 2009	ENERGY STAR Copier Memorandum of Understanding ENERGY STAR Program Requirements for Imaging Equipment	7.4.7
November 16, 2005 Version 1.2, July 1, 2009	ENERGY STAR Program Requirements and Criteria for Room Air Conditioners	7.4.7
Version 4.0 January 1, 2009	ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners	7.4.7
Version 2-0,2.1 April 1, 2002	ENERGY STAR Program Requirements for Boilers	7.4.7
Version 1.12, May 19, 2004 <u>January 22, 2010</u>	ENERGY STAR Program Requirements for Bottled Water Coolers	7.4.7
Version 4.0, December 2, 2008	ENERGY STAR Program Requirements for CFLs	7.4.7
Version 1-05.1, January 1, 2007 <u>July 1, 2009</u>	ENERGY STAR Program Requirements for Clothes Washers	6.3.2.2, 7.4.7
Version 1.1, October 11, 2007	ENERGY STAR Program Requirements for Commercial Dishwashers	6.4.2.2, 7.4.7
Version 1.0, August 15, 2003	ENERGY STAR Program Requirements for Commercial Fryers	7.4.7
Version 1.0, January 1, 2008	ENERGY STAR Program Requirements for Commercial Ice Machines	6.4.2.2, 7.4.7
Version 1.0, August 1, 2003	ENERGY STAR Program Requirements for Commercial Steam Cookers	7.4.7
Version 4-15.0, January 1, 2006 <u>October 30, 2009</u>	ENERGY STAR Program Requirements for Computer Monitors Displays	7.4.7
Version 1-0-2.1, January 1, 2003 <u>July 30, 2010</u>	ENERGY STAR Program Requirements for Consumer Audio and DVD Products-Video	7.4.7
Version 2.0, June 1, 2008	ENERGY STAR Program Requirements for Dehumidifiers	7.4.7
Version 4.1, January 1, 2007 <u>August 11, 2010</u>	ENERGY STAR Program Requirements <u>Product Specification</u> for <u>Residential</u> Dishwashers	6.3.2.2, 7.4.7
Version 2.0, October 1, 2008	ENERGY STAR Program Requirements for Furnaces	7.4.7
Version 2-0 4.1, April 1, 2004 <u>August 11, 2009</u>	ENERGY STAR Program Requirements for Geothermal Heat Pumps	7.4.7
Version 1.0, August 15, 2003	ENERGY STAR Program Requirements for Hot Food Holding Cabinets	7.4.7

January 1, 2004	ENERGY STAR Program Requirements for Light Commercial HVAC	7.4.7
January 1, 2006	ENERGY STAR Program Requirements for Products with Battery Charger Systems (BCSs)	7.4.7
Version 1.2, February 1, 2008	ENERGY STAR Program Requirements for Programmable Thermostats	7.4.7
Version 2.0, July 1, 2007	ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines	7.4.7
Version 1.0, April 28, 2008	ENERGY STAR Program Requirements for Refrigerators and Freezers	7.4.7
Version 2.3, January 1, 2009	ENERGY STAR Program Requirements for Residential Ceiling Fans	7.4.7
Final Version 1.0, April 1, 2008 January 1, 2009	ENERGY STAR Program Requirements for Residential Water Heaters	7.4.7
Version 2.0, December 31, 2007	ENERGY STAR Program Requirements for Roof Products	5.3.2.3
Version 1.0, July 1 2004	ENERGY STAR Program Requirements for Room Air Cleaners	7.4.7
Version 2.1 2.2, January 15, 2009	ENERGY STAR Program Requirements for Residential Ventilating Fans	7.4.7
Version 2.0, November 1, 2008	ENERGY STAR Program Requirements for Single-Voltage AC-DC and AC-AC Power Supplies	7.4.7
Version 1.1 2.0, September 1, 2001 April 1, 2009	ENERGY STAR Program Requirements for <u>Solid Door Commercial Refrigerators and Freezers</u>	7.4.7
Version 2.1, November 1, 2008	ENERGY STAR Program Requirements for Telephony	7.4.7
Version 3.0 4.2, November 1, 2008 April 30, 2010	ENERGY STAR Program Requirements for <u>TVs, VCRs, DCR TVs with POD Slots, Combination Units, Television Monitors, and Component Television Units Televisions</u>	7.4.7
Version 1.0, October 4, 2007	WaterSense Tank-Type High-Efficiency Lavatory Specification	6.3.2.1
Version 1.0, January 24, 2007	WaterSense Tank-Type High-Efficiency Toilet Specification	6.3.2.1
EPA 402-R-93-071, September 1993	U.S. EPA Map of Radon Zones	8.3.5.5
EPA 430-R-07-002, April 2007	Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005	
<u>Version 2.0, January 1, 2009</u>	<u>ENERGY STAR Program Requirements for Set-top Boxes</u>	<u>7.4.7</u>
<u>Version 4.1, August 1, 2008</u>	<u>ENERGY STAR Program Requirements for Residential Light Fixtures</u>	<u>7.4.7</u>
<u>Version 1.2, August 31, 2010</u>	<u>ENERGY STAR Program Requirements for Integral LED Lamps</u>	<u>7.4.7</u>
<u>Version 1.0, May 8, 2009</u>	<u>ENERGY STAR Program Requirements for Commercial Griddles</u>	<u>7.4.7</u>
<u>Version 1.0, May 16, 2009</u>	<u>ENERGY STAR Program Requirements for Commercial Ovens</u>	<u>7.4.7</u>
<u>Version 1.0, October 15, 2010</u>	<u>ENERGY STAR Program Requirements for Computer Servers</u>	<u>7.4.7</u>
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), 1791 Tullie Circle NE Atlanta, GA 30329 United States 1-404-636-8400; www.ashrae.org		
ANSI/ASHRAE/IESNA Standard 90.1-2010 2007 , including addendum i	Energy Standard for Buildings Except Low-Rise Residential Buildings	3.1, 3.2, 5.3.3.1, 5.3.3.2 3 , 7.3.1, 7.4.1, 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.4.6, 7.4.7, 7.4.8, Appendix A, Appendix C, Appendix D
ANSI/ASHRAE Standard 52.2-2007	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size	8.3.1.3
ANSI/ASHRAE Standard 55-2004, including addendum e10	Thermal Comfort Conditions for Human Occupancy	8.3.2, 10.3.1.2.1
ANSI/ASHRAE Standard 62.1- 2007 10	Ventilation for Acceptable Indoor Air Quality	3.2, <u>7.4.3.2, 7.4.3.7, 8.3,</u> 10.3.1.4, 10.3.2.1.4, Appendix D

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FOREWORD

Addendum i updates a requirement that the exterior lighting power density (LPD) values allowed by Standard 189.1 be some percentage of those allowed by ANSI/ASHRAE/IES Standard 90.1-2010. Analysis shows that the exterior LPD values can be reduced by switching the minimum acceptable equipment from magnetic metal halide (MH) ballasts to electronic ballasts. The analysis for Standard 90.1-2010 was done using primarily magnetic MH ballasts as the main light source. Where metal halide was not used fluorescent was used (fluorescent made up less than 10%). Wattages for both Standard 90.1 and Standard 189.1 in accordance with Addendum i are:

Standard 90.1 Equipment (Magnetic)

- 70 MH at 90 watts
- 100 MH at 129 watts
- 150 MH at 185 watts
- 320 MH at 368 watts

Standard 189.1 Equipment (Electronic)

- 70 MH at 80 watts (11.1% less)
- 100 MH at 110 watts (14.7% less)
- 150 MH at 165 watts (10.9% less)
- 320 MH at 345 watts (5.5% less)

The large majority of the analysis models used 70, 100, and 150 MH luminaires, thereby providing from 10.9% to 14.7% savings over Standard 90.1. The 320 MH is used in some lighting zones (LZs), with LZ3 and LZ4 areas showing savings of 5.5%. The composite average resulted in savings

in excess of 10%. However, it was determined that high-performance buildings and the goal of saving energy would be better served by setting the amount of reduction as a function of the type of area under consideration. This addendum requires lighting power density to be determined using a factor of 90% in tradable areas within lighting zones LZ1 and LZ2 and 95% in tradable areas within LZ3, LZ4, and all nontradable areas. LZ0 LPDs shall remain as specified in Standard 90.1-2010.

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Addendum i to Standard 189.1-2009

Modify Section 7.4.6.1 as follows:

7.4.6.1 Lighting Power Allowance. The interior lighting power allowance shall be a maximum of 0.9 multiplied by the values determined in accordance with Sections 9.5 and 9.6 of ANSI/ASHRAE/IES Standard 90.1. ~~This requirement supersedes the requirements in Sections 9.5 and 9.6 of ANSI/ASHRAE/IES Standard 90.1.~~ The exterior lighting power allowance shall be a maximum of 0.9 multiplied by the values determined in accordance with Section 9.4.3 of ANSI/ASHRAE/IES Standard 90.1 multiplied by the corresponding factor found in Table 7.4.6.1C.

Table 7.4.6.1C

	Lighting Zone				
	LZ0	LZ1	LZ2	LZ3	LZ4
For Tradable Areas	1.00	0.90	0.90	0.95	0.95
For Nontradable Areas	1.00	0.95	0.95	0.95	0.95

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FOREWORD

Addendum m clarifies the climates where condensate collection would be required for air-conditioning units by exempting dry climates where little if any condensate would be expected. The threshold value for the design wet-bulb condition was determined from an analytical study of the condensate collected for 36 different cities located in different climatic regions throughout the U.S.

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Addendum m to Standard 189.1-2009

Modify Section 6.3.2.3 of the Standard as follows:

6.3.2.3 HVAC Systems and Equipment

- a. *Once-through cooling with potable water* is prohibited.
- b. Cooling towers and evaporative coolers shall be equipped with makeup and blowdown meters, conductivity controllers, and overflow alarms in accordance with the thresholds listed in Table 6.3.3B. Cooling towers shall be equipped with efficient drift eliminators that achieve drift reduction to a maximum of 0.002% of the recirculated water volume for counterflow towers and 0.005% of the recirculated water flow for cross-flow towers.
- c. Building projects located in regions where the ambient mean coincident wet-bulb temperature at 1% design cooling conditions is greater than or equal to 72°F (22°C) shall have a system for collecting condensate from air-conditioning units with a capacity greater than 65,000 Btu/h (19 kW), and the condensate from all steam systems shall be recovered for re-use.

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FOREWORD

Addendum p clarifies area exceptions for brownfield sites in Section 5.4.1.1.

Per its definition, a brownfield site is not necessarily contaminated, and where contamination is successfully removed from a site, it is acceptable and desirable to allow infiltration. Exception #4 as originally written is overly broad. This revision limits the exception to areas where contamination has been identified but not removed from the soil.

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Addendum p to Standard 189.1-2009

Modify the exception to Section 5.4.1.1 as follows:

5.4.1.1 Effective Pervious Area for All Sites. A minimum of 40% of the entire *site* shall incorporate one or any combination of the following:

- a. shall be vegetated with a minimum depth of growing medium of 12 in. (300 mm). Such vegetated areas include bioretention facilities, rain gardens, filter strips, grass swales, vegetated level spreaders, constructed *wetlands*, planters, or open space with plantings. At least 60% of the vegetated area shall consist of *biodiverse planting of native plants and/or adapted plants*.
- b. shall have a vegetated (green) *roof* with a minimum depth of growing medium of 3 in. (75 mm).
- c. shall have *porous pavers (open grid pavers)*.
- d. shall have *permeable pavement, permeable pavers, or open graded (uniform-sized) aggregate* with a minimum percolation rate of 2 gal/min·ft² (100 L/min·m²) and a minimum of 6 in. (150 mm) of open-graded base below.

Exceptions:

1. The effective pervious surface is allowed to be reduced to a minimum of 20% of the entire *site* if

10% of the average annual rainfall for the entire *development footprint* is captured on *site* and reused for *site* or building water use.

2. The effective pervious surface is not required if 50% of the average annual rainfall for the entire *development footprint* is captured on *site* and reused for *site* or building water use.
3. Locations with less than 10 in. (250 mm) of average annual rainfall.
4. Areas of Bbuilding projects on a brownfield site where contamination has been left in place.

Informative Note: Addendum k to Standard 189.1 modifies portions of 5.4.1.1 related to turfgrass requirements. For your information, the following shows how addendum k and this addendum would look together.

5.4.1.1 Effective Pervious Area for All Sites. A minimum of 40% of the entire *site* shall incorporate one or any combination of the following:

- a. shall be vegetated with a minimum depth of growing medium of 12 in. (300 mm). Such vegetated areas include bioretention facilities, rain gardens, filter strips, grass swales, vegetated level spreaders, constructed *wetlands*, planters, ~~or~~ and open space with plantings. At least 60% of the vegetated area shall consist of *biodiverse planting of native plants and/or adapted plants other than turfgrass*.
- b. shall have a vegetated (green) *roof* with a minimum depth of growing medium of 3 in. (75 mm).
- c. shall have *porous pavers (open grid pavers)*.
- d. shall have *permeable pavement, permeable pavers, or open graded (uniform-sized) aggregate* with a minimum percolation rate of 2 gal/min·ft² (100 L/min·m²) and a minimum of 6 in. (150 mm) of open-graded base below.

Exceptions:

1. The effective pervious surface is allowed to be reduced to a minimum of 20% of the entire *site* if 10% of the average annual rainfall for the entire *development footprint* is captured on *site* and reused for *site* or building water use.
2. The effective pervious surface is not required if 50% of the average annual rainfall for the entire *development footprint* is captured on *site* and reused for *site* or building water use.
3. Locations with less than 10 in. (250 mm) of average annual rainfall.
4. Areas of Bbuilding projects on a brownfield site where contamination has been left in place.

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FOREWORD

Addendum q provides exceptions for safety and functionality and aligns Standard 189.1 with ANSI/ASHRAE/IES Standard 90.1.

Hazardous areas are locations where atmospheres may be exposed to the release of flammable dusts, vapors, or gases in explosive concentrations. The National Electric Code requires that these areas be classified and sets rules for the type of luminaires that may be installed in them. Luminaires are typed in Article 500 of the NEC.

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Addendum q to Standard 189.1-2009

Add exceptions to Section 5.3.3 as follows:

Exceptions to Sections 5.3.3.2 and 5.3.3.3:

1. Specialized signal, directional, and marker lighting associated with transportation.

2. Advertising signage or directional signage.
3. Lighting integral to equipment or instrumentation and installed by its manufacturer.
4. Lighting for theatrical purposes, including performance, stage, film production, and video production.
5. Lighting for athletic playing areas.
6. Lighting that is in use for no more than 60 continuous days and is not re-installed any sooner than 60 days after being uninstalled.
7. Lighting for industrial production, material handling, transportation sites, and associated storage areas.
8. Theme elements in theme/amusement parks.
9. Roadway lighting required by governmental authorities.
10. Lighting classified for and used in hazardous locations as specified in NFPA 70.
11. Lighting for swimming pools and water features.

Add to Section 11, Normative References, as follows:

Reference	Title	Section
<u>National Fire Protection Association</u>		
<u>1 Battery March Park</u>		
<u>Quincy, BA 02169-7471</u>		
<u>United States</u>		
<u>1-617-770-0700;</u>		
<u>www.nfpa.org</u>		
<u>NFPA 70 -2011</u>	<u>National Electrical Code</u>	<u>5.3.3</u>

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FOREWORD

Background

Standard 189.1-2009 uses a blanket LPD Factor of 0.90 relative to ANSI/ASHRAE/IES Standard 90.1-2007 requirements. The lighting power density (LPD) values in Standard 90.1-2010 represent a complete and thorough review of their representation of energy-efficient space lighting, which resulted in an overall whole-building weighted reduction in LPD of approximately 15%. This review included consideration of the latest equipment and efficiencies (lamps, ballasts, luminaires) as well as design options and input from the design community. This process resulted in space and resulting whole-building LPDs for maximum efficiency at rational cost while maintaining minimum lighting levels and reasonable design capability. Reductions in LPD are not considered possible in some space and building types unless some important metric of lighting design is reduced such as light levels, rational initial cost, design flexibility, and potentially issues with occupant comfort.

This addendum abandons an across-the-board reduction in the Standard 90.1 LPDs and adopts reductions based on the specific building and space types. Using the Standard 90.1 models, an analysis that involved reducing flexibility and applying high-cost new technology was used to evaluate which spaces and building LPDs could be reduced without reducing needed light levels. This analysis included the following:

Fluorescent Fixture Efficiency Change. Many LPD models include fluorescent fixtures of various types (lensed, parabolic, direct/indirect, etc.) based on different space types and task needs, including light distribution, glare control, and aesthetics. The characteristics of each fixture type used in the models represent an efficient version of the specific type. The most efficient fixture of all available fluorescent types could be used in the models instead of the most appropriate type so as to increase energy savings. This would reduce energy use in those spaces where the most efficient fixture is not already used. If the most appropriate fixture is replaced with the most efficient regardless of application fit, the minimum light levels would still be maintained in the models but there could be reductions in one or

more quality lighting features, such as glare control, and would eliminate primary design flexibility and associated aesthetics.

Downlight Fixture Efficiency Change with LED Technology. Another option could be using more efficient lighting sources where the most efficacious source is not already used (i.e., light-emitting diode [LED] in place of compact fluorescent [CFL] or incandescent [INC]). The current model inputs for downlights are based on the most efficacious source that is also reasonably cost effective, provides the appropriate lighting color, and has the needed capabilities of distribution and beam intensity. In some applications an LED may be able to provide the same needed lighting capabilities and could replace the CFL or INC source but with a significant increase in costs. For the models where a change can be made, the minimum light levels would be maintained but costs would significantly increase and some lighting quality may be reduced.

Conclusion

Both of these options were applied to the nearly 100 space type models and associated 33 building types to see where reductions could be made. The results show that approximately two thirds of the space types and almost half of the building types had no significant reduction. Tables 7.4.6.1A and 7.4.6.1B added by this addendum list LPD factors for spaces wherein energy reductions are possible with only a modest loss in flexibility and a modest increase in first cost.

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Addendum r to Standard 189.1-2009

Modify section 7.4.6.1 as follows:

7.4.6.1 Lighting Power Allowance. The interior lighting power allowance shall be a maximum of 0.9 multiplied by the values determined in accordance with Sections 9.5 and 9.6 of ANSI/ASHRAE/IESNA Standard 90.1, multiplied by an LPD Factor specified in Table 7.4.6.1A for those areas where the Building Area Method is used and in Table 7.4.6.1B for those areas where the Space-by-Space Method is used. Control factors from Table 9.6.2 in ANSI/ASHRAE/IES Standard 90.1 shall not be used for the control methodologies required in this standard. This requirement supersedes the requirements in Sections 9.5 and 9.6 of ANSI/ASHRAE/IESNA Standard 90.1.

**Table 7.4.6.1A LPD Factors when Using
 the Building Area Method**

Building Area Type	LPD Factor
Courthouse	0.95
Dining—Cafeteria/Fast Food	0.95
Dining—Family	0.95
Dormitory	0.95
Exercise Center	0.95
Healthcare Clinic	0.95
Hospital	0.95
Library	0.95
Multifamily	0.95
Office	0.95
Penitentiary	0.95
Police Station	0.95
Religious Building	0.95
School/University	0.90
Town Hall	0.95
Transportation	0.95
All Other Building Area Types	1.00

**Table 7.4.6.1B LPD Factors when Using
 the Space-by-Space Method**

Common Space Type	LPD Factor
Classroom/Lecture/Training	0.85
Conference Meeting/Multipurpose	0.90
Corridor/Transition	0.85
Dining Area	0.90
Dining Area for Family Dining	0.85
Fitness Center—Fitness Area	0.85
Laboratory for Medical/Industrial Research	0.95
Lobby	0.95
Lobby for Elevator	0.85
Lobby for Motion Picture Theater	0.95
Lounge/Recreation	0.85
Office—Enclosed	0.95
Office—Open Plan	0.85
Sales Area	0.95
All Other Common Space Types	1.00
Building-Specific Space Type	LPD Factor
Convention Center—Exhibit Space	0.85
Courthouse—Courtroom	0.85
Gymnasium—Audience Seating/Permanent Seating	0.85
Gymnasium—Fitness Area	0.85
Hospital—Emergency	0.95
Hospital—Exam/Treatment	0.85
Hospital—Laundry/Washing	0.95
Hospital—Lounge/Recreation	0.85
Hospital—Medical Supply	0.90
Hospital—Nursery	0.85
Hospital—Nurses' Station	0.90
Hospital—Patient Room	0.90
Hospital—Physical Therapy	0.85
Library—Card File and Cataloguing	0.90
Library—Stacks	0.95
Manufacturing Facility—High Bay	0.85
Manufacturing Facility—Low Bay	0.85
Motel—Dining Area	0.90
Transportation—Air/Train/Bus—Baggage Area	0.90
Transportation—Airport—Concourse	0.90
Transportation—Terminal—Ticket Counter	0.85
Warehouse—Medium/Bulky Material Storage	0.85
All Other Building-Specific Space Types	1.00

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FOREWORD

Addendum u requires automatic controls to ensure that lighted signs that are bright enough to be visible during daytime hours are operated during nighttime hours with a 65% reduction in power (reduce power to 35% of full power). Such lighted signs will still be visible at night but will use much less power.

The addendum also requires automatic controls to ensure that all other signs are off during daytime hours to save energy and are operated with a 30% reduction in power after midnight (reduce power to 70% of full power). The requirement for signs that are not electrically illuminated during the day is essentially restating the requirement in Standard 90.1-2010, Section 9.4.1.7(c), and was included here for ease of use.

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Addendum u to Standard 189.1-2009

Add the following definition to Section 3.2:

daylight hours: the period from 30 minutes after sunrise to 30 minutes before sunset.

Add to Section 7.4.6 as follows:

7.4.6.8 Controls for Exterior Sign Lighting. All exterior sign lighting, including internally illuminated signs and lighting on externally illuminated signs, shall comply with the requirements of Sections 7.4.6.8.1 or 7.4.6.8.2.

Exceptions:

- a. Sign lighting that is specifically required by a health or life safety statute, ordinance, or regulation.
- b. Signs in tunnels.

7.4.6.8.1 All sign lighting that operates more than one hour per day during *daylight hours* shall include controls to automatically reduce the input power to a maximum of 35% of full power for a period from one hour after sunset to one hour before sunrise.

Exception: Sign lighting using metal halide, high-pressure sodium, induction, cold cathode, or neon lamps that includes controls to automatically reduce the input power to a maximum of 70% of full power for a period from one hour after sunset to one hour before sunrise.

7.4.6.8.2 All other sign lighting shall include:

- a. controls to automatically reduce the input power to a maximum of 70% of full power for a period from midnight or within one hour of the end of business operations, whichever is later, until 6:00 am or business opening, whichever is earlier, and
- b. controls to automatically turn off during *daylight hours*.

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FOREWORD

Addendum v adds a minimum time period to automatic control requirements for guest rooms in hotels. Without a minimum time period, lights could be turned off 1 second after vacancy or 24 hours after vacancy and still comply. A minimum requirement of 30 minutes of vacancy is deemed an appropriate time period for lighting, TV, switched outlets, and HVAC setpoint adjustments. If desired, a hotel can always choose to turn off lighting and power or adjust HVAC setpoints less than 30 minutes after vacancy but not longer than 30 minutes after vacancy.

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Addendum v to Standard 189.1-2009

Add to Section 7.4.3.12 as follows:

7.4.3.12 Automatic Control of HVAC and Lights in Hotel/Motel Guest Rooms. In hotels and motels with over 50 guest rooms, the lighting, switched outlets, television, and HVAC equipment serving each guest room shall be automatically controlled such that the power for lighting, switched outlets, and televisions will be turned off within 30 minutes after all occupants leave the guest room and the HVAC setpoints raised by at least 5°F (3°C) in the cooling mode and lowered by at least 5°F (3°C) in the heating mode ~~whenever~~ within 30 minutes after all occupants leave the guest room-is unoccupied.

Exception: Guest rooms where the lighting, switched outlets, and televisions are turned off and the HVAC setpoints are raised by at least 5°F (3°C) in the cooling mode and lowered by at least 5°F (3°C) in the heating mode when the occupant removes the card from a captive key system.

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FOREWORD

Addendum w adds automatically controlled dynamic building façade systems as alternatives to the permanent projection requirements in Sections 7.4.2.5 and 8.4.1.2. These alternatives include dynamic glazing and dynamic shading systems whose solar-optical properties, and thus solar heat gain coefficient (SHGC) and visible transmittance (VT), can be modified in response to daylight levels or solar intensity. Because of the ability of these systems to provide dynamic responses at different times of the day and year, dynamic systems may be capable of equal or better performance than fixed overhangs in terms of energy efficiency (Section 7) and glare control (Section 8). Furthermore, dynamic glazing and shading systems are an important part of the Department of Energy Building Technologies program. This addendum includes requirements for multilevel automatic control, acceptance testing, and commissioning, along with minimum performance criteria for dynamic glazing and dynamic shading systems.

Further information on the supporting rationale from Lawrence Berkeley National Laboratory may be found at www.mediafire.com/add_w_rationale.

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Addendum w to Standard 189.1-2009

Modify Section 7.4.2 as follows:

7.4.2.5 Permanent Projections. For climate zones 1-5, the *vertical fenestration* on the west, south, and east shall be shaded by permanent projections that have an area-weighted average *PF* of not less than 0.50. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance.

Exceptions:

1. *Vertical fenestration* that receives direct solar radiation for fewer than 250 hours per year because of shading by permanent external buildings, existing permanent infrastructure, or topography.
2. *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 4 hours.
 - d. Acceptance testing and commissioning shall be conducted as required by Section 10 to verify that automatic controls for shading devices respond to changes in illumination or radiation intensity.
3. *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 *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 Section 10 to verify that automatic controls for *dynamic glazing* respond to changes in illumination or radiation intensity.

Modify Section 8.4.1.2 as follows:

8.4.1.2 Office Space Shading. Each west-, south-, and east-facing facade, shall be designed with a shading *PF*. The *PF* shall be not less than 0.5. Shading is allowed to be external or internal using the *interior PF*. The building is allowed to be rotated up to 45 degrees for purposes of calculations and showing compliance. The following shading devices are allowed to be used:

- a. Louvers, sun shades, light shelves, and any other permanent device. Any *vertical fenestration* that employs a combination of interior and external shading is allowed to be separated into multiple segments for compliance purposes. Each segment shall comply with the requirements for either external or *interior projection factor*.
- b. Building self-shading through *roof* overhangs or recessed windows.

Exceptions:

1. Translucent panels and glazing systems with a measured haze value greater than 90%, tested according to ASTM D1003 (notwithstanding its scope) or other

test method approved by the *authority having jurisdiction*, and that are entirely 8 ft (2.5 m) above the floor, do not require external shading devices.

2. *Vertical fenestration* that receives direct solar radiation for less than 250 hours per year because of shading by permanent external buildings, existing permanent infrastructure, or topography.
3. *Vertical fenestration with automatically controlled shading devices in compliance with Exception 2 of Section 7.4.2.5.*
4. *Vertical fenestration with automatically controlled dynamic glazing in compliance with Exception 3 of Section 7.4.2.5.*

Modify Section 10.3.1 as follows:

10.3.1.1.3 Systems. The following systems, if included in the *building project*, shall have acceptance testing:

- a. Mechanical Systems: Heating, ventilating, air conditioning, IAQ, and refrigeration systems (mechanical and/or passive) and associated controls.
- b. Lighting Systems: Automatic daylighting controls, manual daylighting controls, occupancy sensing devices, and, automatic shut-off controls.
- c. Fenestration Control Systems: Automatic controls for shading devices and dynamic glazing.

- ed. Renewable energy systems.
- de. Energy measurement devices, as required in 7.3.3.
- ef. Water measurement devices, as required in 6.3.3.

10.3.1.2.4 Systems. The following systems, if included in the building project, shall be commissioned:

- a. Heating, ventilating, air-conditioning, IAQ, and refrigeration systems (mechanical and/or passive) and associated controls. Control sequences to be verified for compliance with construction documentation as part of *verification*.
- b. *Building envelope* systems, components, and assemblies to verify the thermal and moisture integrity.
- c. *Building envelope* pressurization to confirm air-tightness if included in *BOD* requirements.
- d. ~~All lighting systems controls and shading controls.~~
- e. Fenestration control systems: Automatic controls for shading devices and dynamic glazing.
- ef. Irrigation.
- fg. Plumbing.
- gh. Domestic and process water pumping and mixing systems.
- hi. *Service water heating* systems.
- ij. Renewable energy systems.
- jk. Water measurement devices, as required in Section 6.3.3.
- kl. Energy measurement devices, as required in Section 7.3.3.