ANSI/ASHRAE/USGBC/IES Standard 189.1-2014

(Supersedes ANSI/ASHRAE/USGBC/IES Standard 189.1-2011)

Standard for the Design of High-Performance Green Buildings

Except Low-Rise Residential Buildings

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A Compliance Option of the International Green Construction Code™

See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the U.S. Green Building Council, the Illuminating Engineering Society of North America, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org), or in paper form from the ASHRAE Manager of Standards.

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This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *Consensus* is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this standard as an ANS, as "substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with this standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Manager of Standards of ASHRAE should be contacted for:

a. interpretation of the contents of this Standard,
b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard, or
d. permission to reprint portions of the Standard.

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ANSI/ASHRAE/USGBC/IES Standard 189.1-2014, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

NOTE

Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE Web site at www.ashrae.org/technology.

(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

ANSI/ASHRAE/USGBC/IES Standard 189.1 was originally created through a collaborative effort involving ASHRAE, the U.S. Green Building Council, and the Illuminating Engineering Society. Like its 2009 and 2011 predecessors, the 2014 version of the standard is written in code-intended language so that it may be referenced or adopted by enforcement authorities to provide the minimum acceptable level of design criteria for high-performance green buildings. States and local jurisdictions within the United States that wish to adopt Standard 189.1 into law may want to review applicable federal laws regarding preemption and related waivers that are available from the U.S. Department of Energy (www1.eere.energy.gov/buildings/appliance_standards/ state_petitions.html).

Building projects, which are defined in the standard to include both the building and the site, result in potentially significant energy and environmental impacts through their design, construction, and operation. The U.S. Green Building Council reports that buildings in the United States are responsible for 38% of U.S. carbon dioxide emissions, 41% of U.S. energy consumption, and 14% of U.S. water consumption, and contribute 5.5% to GDP per year just for construction. In addition, development frequently converts land from biologically diverse natural habitat that manages rain runoff to impervious hardscape with reduced biodiversity.

While buildings consume energy and have other environmental impacts, they also contribute significantly to national economies and provide critical amenities to building occupants who live in, work in, and otherwise use buildings. Based on a combination of research and practical experience, it is clear that buildings can provide these amenities with reduced energy use, greenhouse gas emissions, water use, heat island and light pollution effects, and impacts on the atmosphere, materials, and resources.

The far-reaching effects of buildings have led to many actions to reduce their energy and environmental impacts. To help meet its responsibility to support such actions, ASHRAE Standing Standard Project Committee (SSPC) 189.1 has used the ASHRAE continuous maintenance process to update the standard in response to input from all segments of the building community. Compliance with these updated provisions will further reduce energy and environmental impacts through high-performance building design, construction, and operation, while providing indoor environments that support the activities of building occupants.

The project committee members represent a broad cross section of the building community and include designers, owners, operators, installation contractors, equipment and product manufacturers, industry trade organizations, code officials, researchers, regulators, and sustainable development experts. This diverse group considers a variety of factors in developing the provisions of the standard, including published research, justification for proposals received from outside the committee, and the committee members' professional judgment.

Provisions within the standard are not uniformly subjected to economic assessment. Cost-benefit assessment, while an important consideration in general, is not a necessary criterion for acceptance of any given change to the standard. However, the practicality and existing application of all the standard's requirements are considered before they are included.

Standard 189.1 addresses site sustainability, water use efficiency, energy use efficiency, indoor environmental quality, and the building's impact on the atmosphere, materials, and resources. The standard devotes a section to each of these subject areas, as well as a separate section related to plans for construction and high-performance operation.

All words and phrases that are defined in the standard are displayed in italics to indicate that they are being used in a manner that may differ from their common definition.

New provisions of the 2014 standard relative to the 2011 version are summarized below, but not all changes are identified specifically. Appendix H of the standard identifies all addenda to the 2011 version that are included in the 2014 edition.

- *Since Standard 189.1 adopts by reference many requirements from other ASHRAE standards, the 2014 version updates requirements to reflect the most current version of each referenced standard. Specifically, it refers to Standards 90.1-2013 and 62.1-2013.*
- *Site Sustainability: All site requirements have been made mandatory, with the prescriptive and performance options moved to the mandatory requirements. In addition, the requirements relative to stormwater management have been enhanced, and new requirements have been added for bicycle parking; preferred parking for low-emission, hybrid, and electric vehicles; and a predesign assessment of native and invasive plants.*
- *Water: The stringency of the water use requirements are increased for toilets, clothes washers, dishwashers, and green roofs.*
- *Energy: Significant updates were made to reflect the publication of Standard 90.1-2013. These include revised building envelope provisions, which are now specified as a percent increase in stringency as compared to Standard 90.1-2013. Building envelope assemblies in compliance can be found in Informative Appendix E. Fenestration orientation requirements were also updated based on new research. Updates also include changes to the equipment efficiency tables that were originally in Appendix C in 189.1-2011 and are now in Appendix B. Energy Star references have also been updated, and clarity has been provided as to which apply to all buildings and which apply to the Alternative Renewables Approach. The continuous air-barrier requirements have been removed from the energy section, although buildings must still*

comply with Standard 90.1-2013 with no exceptions for climate zones. Either whole-building pressurization testing or an air-barrier commissioning program is now required in Section 10.

- *Energy Performance, Carbon Dioxide Emissions, and Renewables: The requirements for energy performance and renewable energy have been modified. Most of the modifications clarify existing requirements and reflect changes to Standard 90.1. The carbon dioxide emission factors for different energy sources have also been updated.*
- *Indoor Environmental Quality: Lighting quality has been added to the scope of this section and requirements have been added for lighting controls in specific space types. The fact that Standard 62.1 no longer contains requirements for healthcare facilities, which are now covered by ANSI/ASHRAE/ASHE Standard 170,* Ventilation of Health Care Facilities*, is reflected by specific reference to Standard 170 for those facilities. The requirements for air sealing of filtration and air-cleaning equipment have been clarified, and new requirements for preoccupancy ventilation and building envelope moisture management have been added.*
- *Building Impacts on the Atmosphere, Materials, and Resources: The requirements for areas to store and collect recyclables, including batteries and electronics, for construction waste management and for life-cycle assessment have been updated. New requirements were also added for multiple-attribute product declaration or certification and maximum mercury content levels of certain types of electric lamps.*
- *Construction and Plans for Operation: In addition to the air-barrier testing requirements noted in bullet four above, this section has updated requirements related to the environmental impacts associated with the idling of construction vehicles and new requirements to reduce the entry of airborne contaminants associated with construction areas.*

As was the case in the 2011 edition of the standard, each section (other than 5 and 10) follows a similar format:

X.1 General. This subsection includes a statement of scope and addresses other broad issues for the section.

x.2 Compliance Paths. This subsection indicates the compliance options available within a given section.

x.3 Mandatory Provisions. This subsection contains mandatory provisions that apply to all projects (i.e., provisions that must be met and may not be ignored in favor of equal or more stringent provisions found in other subsections).

x.4 Prescriptive Option. This subsection—an alternative to the Performance Option—contains prescribed provisions that must be met in addition to all mandatory provisions. Prescribed provisions are intended to offer a simple compliance approach that involves minimal calculations.

x.5 Performance Option. This subsection—an alternative to the Prescriptive Option—contains performance-based provisions that must be met in addition to all mandatory provisions. Performance provisions are intended to offer a more complex alternate compliance approach that typically involves simulation or other calculations, which are expected to result in the same or better performance than compliance with prescribed provisions.

SSPC 189.1 considers and responds to proposed changes to this continuous maintenance standard and provides interpretations of the standard's requirements on request. Proposed changes to the standard may originate within or outside of the committee. The committee welcomes proposals for improving the standard using ANSI-approved ASHRAE continuous maintenance procedures. A continuous maintenance proposal (CMP) form can be found online at www.ashrae.org/standards-research--technology/standards--guidelines/continuous-maintenance. A hard copy of the form can be found in the back of this standard and may be completed and submitted at any time. The committee takes formal action on every proposal received, which often results in changes to the published standard. ASHRAE posts approved addenda in publication notices on the ASHRAE website. To receive notice of all public reviews, approved and published addenda, errata, and interpretations, as well as meeting notices, ASHRAE encourages interested parties to sign up for the ASHRAE Listserv for this standard (www.ashrae.org/resources--publications/periodicals/listserves).

1. PURPOSE

The purpose of this standard is to provide minimum requirements for the siting, design, construction, and plan for operation of *high-performance green buildings* to

a. balance environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity; and
b. support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

2. SCOPE

2.1 This standard provides minimum criteria that

a. apply to the following elements of *building projects*:
   1. New buildings and their systems.
   2. New portions of buildings and their systems.
   3. New systems and equipment in existing buildings.
b. address *site* sustainability, water use efficiency, energy efficiency, indoor environmental quality (IEQ), and the building's impact on the atmosphere, materials, and resources.

2.2 The provisions of this standard do not apply to

a. single-family houses, multifamily structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular), and
b. buildings that use none of the following: electricity, fossil fuel, or water.

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

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 herein, but that are defined in standards that are referenced herein (e.g., ANSI/ASHRAE/IES Standard 90.1), shall have the meanings as defined in those standards.

Other 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 *authority having jurisdiction*.

3.2 Definitions

acceptance representative: an entity identified by the *owner* who leads, plans, schedules, and coordinates the activities needed to implement the building acceptance testing activities. The *acceptance representative* may be a qualified employee or consultant of the *owner*. The individual serving as the *acceptance representative* shall be independent of the project design and construction management, though this individual may be an employee of a firm providing those services.

adapted plants: see *plants, adapted plants.*

adequate transit service: at least two buses (including bus rapid transit), streetcars, or *light rail* trains per hour on weekdays, operating between 6:00 a.m. and 9:00 a.m., and between 3:00 p.m. and 6:00 p.m., or at least five heavy passenger rail or ferries operating between 6:00 a.m. and 9:00 a.m., and between 3:00 p.m. and 6:00 p.m.

agricultural land: land that is, or was within ten years prior to the date of the building permit application for the *building project*, primarily devoted to the commercial production of horticultural, viticultural, floricultural, dairy, apiary, vegetable, or animal products or of berries, grain, hay, straw, turf, seed, finfish in upland hatcheries, or livestock, and that has long-term commercial significance for agricultural production. Land that meets this definition is *agricultural land* regardless of how the land is zoned by the local government with zoning jurisdiction over that land.

air, outdoor: see ANSI/ASHRAE Standard 62.1.

airflow, minimum outdoor: the *outdoor airflow* provided by a ventilation system to meet requirements for indoor air quality, excluding any additional *outdoor air* intake to reduce or eliminate the need for *mechanical cooling*.

alternate on-site sources of water: see *water, alternate on-site sources of*.

alternative daily cover: cover material, other than earthen material, placed on the surface of the active face of a municipal solid-waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.

attic and other roofs: see ANSI/ASHRAE/IES Standard 90.1.

authority having jurisdiction (AHJ): the agency or agent responsible for enforcing this standard.

automatic: see ANSI/ASHRAE/IES Standard 90.1

baseline building design: see ANSI/ASHRAE/IES Standard 90.1.

baseline building performance: see ANSI/ASHRAE/IES Standard 90.1.

Basis of Design (BoD): a document that records the concepts, calculations, decisions, and product selections used to meet the *owner's project requirements* and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process. (See *owner's project requirements*.)

bilevel lighting control: lighting control in a *space* that provides at least one intermediate level of lighting power in addition to fully on and fully off. Continuous dimming systems are covered by this definition.

biobased product: a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable agricultural materials (including plant, animal, and marine materials) or forestry materials.

biodiverse plantings: nonhomogeneous, multiple-species plantings.

breathing zone: see ANSI/ASHRAE Standard 62.1.

brownfield site: a *site* documented as contaminated by means of an ASTM E1903 Phase II Environmental Site Assessment or a *site* classified as a brownfield by a local, state, or federal government agency.

building entrance: see ANSI/ASHRAE/IES Standard 90.1.

building envelope: see ANSI/ASHRAE/IES Standard 90.1.

building project: a building, or group of buildings, and *site* that utilize a single submittal for a construction permit or that are within the boundary of contiguous properties under single ownership or effective control. (See *owner*.)

carbon dioxide equivalent (CO_2e): a measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO_2e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas, relative to that of carbon dioxide (CO_2). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO_2. The following GWP values are used based on a 100-year time horizon: 1 for CO_2, 25 for methane (CH_4), and 298 for nitrous oxide (N_2O).

classroom: a *space* primarily used for scheduled instructional activities.

climate zone: see Section 5.1.4 of ANSI/ASHRAE/IES Standard 90.1.

commissioning authority (CxA): an entity identified by the *owner* who leads, plans, schedules, and coordinates the commissioning team to implement the building *commissioning process*. (See *commissioning* [*Cx*] *process*.)

commissioning (Cx) plan: a document that outlines the organization, schedule, allocation of resources, and documentation requirements of the building *commissioning process*. (See *commissioning* [*Cx*] *process*.)

commissioning (Cx) process: a quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the *owner's project requirements*. (See *owner's project requirements*.)

conditioned space: see ANSI/ASHRAE/IES Standard 90.1.

construction checklist: a form used by the contractor to verify that appropriate components are on site, ready for installation, correctly installed, and functional.

construction documents: see ANSI/ASHRAE/IES Standard 90.1.

contaminant: see ANSI/ASHRAE Standard 62.1.

continuous air barrier: see ANSI/ASHRAE/IES Standard 90.1.

cycles of concentration: the ratio of makeup rate to the sum of the blowdown and drift rates.

daylight area: area in an *enclosed space* that is in the *primary sidelighted area*, *daylight area under roof monitors*, or *daylight area under skylights*.

daylight area under roof monitors: see ANSI/ASHRAE/IES Standard 90.1.

daylight area under skylights: see ANSI/ASHRAE/IES Standard 90.1.

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

demand control ventilation (DCV): see ANSI/ASHRAE/IES Standard 90.1.

densely occupied space: those *spaces* with a design occupant density greater than or equal to 25 people per 1000 ft^2 (100 m^2).

design professional: see ANSI/ASHRAE/IES Standard 90.1.

designated park land: federal-, state-, or local-government-owned land that is formally designated and set aside as park land or a wildlife preserve.

dwelling unit: see ANSI/ASHRAE/IES Standard 90.1.

dynamic glazing: see ANSI/ASHRAE/IES Standard 90.1.

electronics: computers and accessories; monitors; printers; and other equipment, such as scanners, fax machines, electric typewriters, cell phones, telephones, answering machines, shredders, postage machines, televisions, VHS/DVD players, portable cassette/CD players with radio devices, and stereo equipment.

emergency ride home: access to transportation home in the case of a personal emergency or unscheduled overtime for employees who commute via transit, carpool, or vanpool.

enclosed space: See ANSI/ASHRAE/IES Standard 90.1.

evapotranspiration (ET): the sum of evaporation and plant transpiration. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves.

> ***ET_c:*** *evapotranspiration* of the plant material derived by multiplying ET_o by the appropriate plant coefficient.
>
> ***ET_o:*** maximum *evapotranspiration* as defined by the standardized Penman-Monteith equation or from the National Weather Service, where available.

expressway: a divided highway with a minimum of four lanes, which has controlled access for a minimum of ten miles (16 kilometers) and a posted minimum speed of at least 45 mph (70 km/h).

fenestration: see ANSI/ASHRAE/IES Standard 90.1.

fenestration area: see ANSI/ASHRAE/IES Standard 90.1.

fish and wildlife habitat conservation area: areas with which state or federally designated endangered, threatened, or sensitive species have a primary association.

forest land: all designated state forests, national forests, and all land that is, or was within ten years prior to the date of the

building permit for the *building project*, primarily devoted to growing trees for long-term commercial timber production.

generally accepted engineering standard: see ANSI/ASHRAE/IES Standard 90.1.

geothermal energy: heat extracted from the Earth's interior and used to produce electricity or mechanical power or provide thermal energy for heating buildings or processes. *Geothermal energy* does not include systems such as heat pumps that use energy independent of the geothermal source to raise the temperature of the extracted heat.

greenfield site: a *site* of which 20% or less has been previously developed with impervious surfaces.

greyfield site: a *site* of which more than 20% is currently or has been previously developed with impervious surfaces.

gross roof area: see ANSI/ASHRAE/IES Standard 90.1.

gross wall area: see ANSI/ASHRAE/IES Standard 90.1.

hardscape: *site* paved areas, including roads, driveways, parking lots, walkways, courtyards, and plazas.

heat island effect: the tendency of urban areas to be at a warmer temperature than surrounding rural areas.

high-performance green building: a building designed, constructed, and capable of being operated in a manner that increases environmental performance and economic value over time, seeks to establish an indoor environment that supports the health of occupants, and enhances satisfaction and productivity of occupants through integration of environmentally preferable building materials and water-efficient and energy-efficient systems.

high-speed door: a nonswinging door used primarily to facilitate vehicular access or material transportation, and having an *automatic* closing device with an opening rate of not less than 32 in./s (810 mm/s) and a closing rate of not less than 24 in./s (610 mm/s).

hydrozoning: to divide the landscape irrigation system into sections in order to regulate each zone's water needs based on plant materials, soil, and other factors.

improved landscape: any disturbed area of the *site* where new plant and/or grass materials are to be used, including green *roofs*, plantings for stormwater controls, planting boxes, and similar vegetative use. *Improved landscape* shall not include *hardscape* areas such as sidewalks, driveways, other paved areas, and swimming pools or decking.

integrated design process: a design process utilizing early collaboration among representatives of each stakeholder and participating consultant on the project. Unlike the conventional or linear design process, integrated design requires broad stakeholder/consultant participation.

integrated project delivery**:** see *integrated design process*.

interior projection factor: see *projection factor, interior.*

irrigation adequacy: a representation of how well irrigation meets the needs of the plant material. This reflects the percentage of required water for turf or plant material supplied by rainfall and controller-scheduled irrigations.

irrigation excess: a representation of the amount of irrigation water applied beyond the needs of the plant material. This reflects the percentage of water applied in excess of 100% of required water.

isolation devices: see ANSI/ASHRAE/IES Standard 90.1.

landscape establishment period: a time period, beginning on the date of completion of permanent plantings and not exceeding 18 months, intended to allow the permanent landscape to become sufficiently established to remain viable.

life-cycle assessment (LCA): a compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a building system throughout its life cycle. *LCA* addresses the environmental aspects and potential environmental impacts (e.g., use of resources and environmental consequences of releases) throughout a building's life cycle, from raw material acquisition through manufacturing, construction, use, operation, end-of-life treatment, recycling, and final disposal (end of life). The purpose is to identify opportunities to improve the environmental performance of buildings throughout their life cycles.

light rail: a streetcar-type vehicle that has step entry or level boarding entry and is operated on city streets, semiexclusive rights-of-way, or exclusive rights-of-way.

lighting power allowance: see ANSI/ASHRAE/IES Standard 90.1.

lighting quality: the degree to which the luminous environment in a *space* supports the requirements of the occupants.

lighting zone (LZ): an area defining limitations for outdoor lighting.

> ***LZ0:*** undeveloped areas within national parks, state parks, *forest land*, rural areas, and other undeveloped areas as defined by the *AHJ*.
>
> ***LZ1:*** developed areas of national parks, state parks, *forest land*, and rural areas.
>
> ***LZ2:*** areas predominantly consisting of *residential* zoning, neighborhood business districts, light industrial with limited night time use, and *residential* mixed-use areas.
>
> ***LZ3:*** all areas not included in *LZ0*, *LZ1*, *LZ2*, or *LZ4*.
>
> ***LZ4:*** high-activity commercial districts in major metropolitan areas as designated by the local jurisdiction.

liner system (Ls): an insulation system for a metal building *roof* that includes the following components. A continuous membrane is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the 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 (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 or otherwise noted.

low-impact trail: erosion-stabilized pathway or track that utilizes natural groundcover or installed system greater than 50% pervious. The pathway or track is designed and used

only for pedestrian and nonmotorized vehicles (excluding power-assisted conveyances for individuals with disabilities).

low-voltage dry-type distribution transformers: transformers that are not oil- or fluid-cooled, with an input voltage less than or equal to 600 V, that range in size from 15 to 333 kVA for single-phase and 15 to 1000 kVA for three-phase equipment and are used for general-purpose applications as described in 42 USC§ 6291.

maintenance plan: see *maintenance program* in ANSI/ASHRAE/ACCA Standard 180.

makeup air: see ANSI/ASHRAE Standard 62.1.

mechanical cooling: see ANSI/ASHRAE/IES Standard 90.1

minimum outdoor airflow rate: see *airflow, minimum outdoor.*

multilevel lighting control: lighting control in a *space* that provides at least two intermediate levels of lighting power in addition to fully on and fully off. Continuous dimming systems are covered by this definition.

native plants: see *plants, native plants*.

networked guest-room control system: an energy management control system, accessible from the hotel/motel front desk or other central location, that is capable of identifying reserved rooms according to a timed schedule and is capable of controlling each hotel/motel guest room separately.

nonpotable water: see *water, nonpotable*.

nonresidential: see ANSI/ASHRAE/IES Standard 90.1.

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

occupant load: the number of persons for which the means of egress of a building or portion thereof is designed.

occupiable space: see ANSI/ASHRAE Standard 62.1.

office furniture system: either a panel-based workstation comprising modular interconnecting panels, hang-on components, and drawer/filing components, or a freestanding grouping of furniture items and their components that have been designed to work in concert.

on-site renewable energy system: photovoltaic, solar thermal, *geothermal energy*, and wind systems used to generate energy and located on the *building project*.

once-through cooling: the use of water as a cooling medium where the water is passed through a heat exchanger one time and is then discharged to the drainage system. This also includes the use of water to reduce the temperature of condensate or process water before discharging it to the drainage system.

open-graded (uniform-sized) aggregate: materials such as crushed stone or decomposed granite that provide 30% to 40% void *spaces*.

outdoor air: see *air, outdoor.*

outdoor air fault condition: a situation in which the measured *minimum outdoor airflow* of a ventilation system is 10% or more below the setpoint value that corresponds to the occupancy and operation conditions at the time of the measurement.

owner: the party in responsible control of development, construction, or operation of a project at any given time.

owner's project requirements (OPR): a written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

permanently installed: see ANSI/ASHRAE/IES Standard 90.1.

permeable pavement: pervious concrete or porous asphalt that allows the movement of water and air through the paving material, and which is primarily used as paving for roads, parking lots, and walkways. Permeable paving materials have an open-graded coarse aggregate with interconnected voids.

permeable pavers: units that present a solid surface but allow natural drainage and migration of water into the base below by permitting water to drain through the *spaces* between the pavers.

plants:

a. ***adapted plants:*** *plants* that reliably grow well in a given habitat with minimal attention from humans in the form of winter protection, pest protection, water irrigation, or fertilization once root systems are established in the soil. *Adapted plants* are considered to be low maintenance but not invasive.
b. ***invasive plants:*** species of *plants* that are not native to the *building project site* and that cause or are likely to cause environmental harm. At a minimum, the list of invasive species for a *building project site* includes *plants* included in city, county, and regional lists and state and federal noxious weeds laws.
c. ***native plants:*** *plants* that adapted to a given area during a defined time period and are not invasive. In America, the term often refers to *plants* growing in a region prior to the time of settlement by people of European descent.

porous pavers (open-grid pavers): units where at least 40% of the surface area consists of holes or openings that are filled with sand, gravel, other porous material, or vegetation.

postconsumer recycled content: proportion of *recycled material* in a product generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. (See *recycled material*.)

potable water: see *water, potable*.

preconsumer recycled content: proportion of *recycled material* in a product diverted from the waste stream during the manufacturing process. Content that shall not be considered preconsumer recycled includes the reutilization of materials such as rework, regrind, or scrap generated in a process and

capable of being reclaimed within the same process that generated it. (See *recycled material*.)

primary sidelighted area: see ANSI/ASHRAE/IES Standard 90.1.

projection factor (PF): see ANSI/ASHRAE/IES Standard 90.1.

projection factor (PF), interior: the ratio of the horizontal depth of the interior shading projection divided by the sum of the height of the *fenestration* above the interior shading projection and, if the interior projection is below the bottom of the *fenestration*, the vertical distance from the bottom of the *fenestration* to the top of the farthest point of the interior shading projection, in consistent units.

proposed building performance: see ANSI/ASHRAE/IES Standard 90.1.

proposed design: see ANSI/ASHRAE/IES Standard 90.1.

public way: a street, alley, transit right of way, or other parcel of land open to the outdoors and leading to a street or transit right of way that has been deeded, dedicated, or otherwise permanently appropriated to the public for public use and that has a clear width and height of not less than 10 ft (3 m).

recovered material: material that would have otherwise been disposed of as waste or used for energy recovery (e.g., incinerated for power generation) but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or a manufacturing process.

recycled content: proportion by mass of *recycled material* in a product or packaging. Only preconsumer and postconsumer materials shall be considered as *recycled content*. (See *recycled material*.)

recycled material: material that has been reprocessed from *recovered* (reclaimed) *material* by means of a manufacturing process and made into a final product or into a component for incorporation into a product. (See *recovered material*.)

regulated energy use: energy use defined as *regulated energy use* by ANSI/ASHRAE/IES Standard 90.1, plus energy used by building systems and components with requirements prescribed in Section 7.4.

residential: see ANSI/ASHRAE/IES Standard 90.1.

roof: see ANSI/ASHRAE/IES Standard 90.1.

roof area, gross: see ANSI/ASHRAE/IES Standard 90.1.

roof monitor: see ANSI/ASHRAE/IES Standard 90.1.

salvaged material: material, component, or assembly removed in a whole form from a structure or *site* in which it was *permanently installed* and subsequently reused in the *building project*.

seating: task and guest chairs used with *office furniture systems*.

secondary sidelighted area: see ANSI/ASHRAE/IES Standard 90.1.

semiheated space: see ANSI/ASHRAE/IES Standard 90.1.

service water heating: see ANSI/ASHRAE/IES Standard 90.1.

sidelighting: daylighting provided by *vertical fenestration* mounted below the ceiling plane.

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

$$\textit{Sidelighting effective aperture} = \frac{\sum \text{Window area} \times \text{Window VLT}}{\text{Area of } \textit{primary sidelighted area}}$$

where "Window VLT" is the visible light transmittance of windows as determined in accordance with Section 5.8.2.6 of ANSI/ASHRAE/IES Standard 90.1.

single-rafter roof: see ANSI/ASHRAE/IES Standard 90.1.

site: a contiguous area of land that is under the ownership or control of one entity.

skylight: see ANSI/ASHRAE/IES Standard 90.1.

skylight effective aperture: see ANSI/ASHRAE/IES Standard 90.1.

smart controller (weather-based irrigation controller): a device that estimates or measures depletion of water from the soil moisture reservoir and operates an irrigation system to replenish water as needed while minimizing excess.

soil gas retarder system: a combination of measures that retard vapors in the soil from entering the occupied *space*.

solar energy system: any device or combination of devices or elements that rely upon direct sunlight as an energy source, including but not limited to any substance or device that collects sunlight for use in

a. heating or cooling of a structure or building;
b. heating or pumping of water;
c. industrial, commercial, or agricultural processes; and
d. generation of electricity.

solar heat gain coefficient (SHGC): see ANSI/ASHRAE/IES Standard 90.1.

solar reflectance index (SRI): a measure of a constructed surface's ability to reflect solar heat, as shown by a small temperature rise. A standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100.

space: see ANSI/ASHRAE/IES Standard 90.1.

***SWAT*:** smart water application technology as defined by the Irrigation Association.

task lighting: see ANSI/ASHRAE/IES Standard 90.1.

transfer air: see ANSI/ASHRAE Standard 62.1.

tubular daylighting device: a means to capture sunlight from a rooftop. Sunlight is then redirected down from a highly reflective shaft and diffused throughout interior *space*.

turfgrass: grasses that are regularly mowed and, as a consequence, form a dense growth of leaf blades, shoots, and roots.

variable-air-volume (VAV) system: see ANSI/ASHRAE/IES Standard 90.1.

vendor: a company that furnishes products to project contractors and/or subcontractors for on-site installation.

verification: the process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the *owner's project requirements*. (See *owner's project requirements*.)

vertical fenestration: see ANSI/ASHRAE/IES Standard 90.1.

wall: see ANSI/ASHRAE/IES Standard 90.1.

wall area, gross: see ANSI/ASHRAE/IES Standard 90.1.

water, alternate on-site sources of: *alternate on-site sources of water* include, but are not limited to

a. rainwater or stormwater harvesting,
b. air conditioner condensate,
c. gray water from interior applications and treated as required,
d. swimming pool filter backwash water,
e. cooling tower blowdown water,
f. foundation drain water,
g. industrial process water, and
h. on-site wastewater treatment plant effluent.

water, nonpotable: water that is not *potable water*. (See *water, potable*.)

water, potable: water from public drinking water systems or from natural freshwater sources, such as lakes, streams, and aquifers, where water from such natural sources would or could meet drinking water standards.

water, reclaimed: *nonpotable water* derived from the treatment of waste water by a facility or system licensed or permitted to produce water meeting the jurisdiction's water requirements for its intended uses, including but not limited to above-surface landscape irrigation.

water factor (WF):

a. ***clothes washer (residential* and *commercial):*** the quantity of water in gallons (litres) used to wash each cubic foot (cubic metre) of machine capacity.
b. ***residential dishwasher:*** the quantity of water use in gallons (litres) per full machine wash and rinse cycle.

weatherproofing system: a group of components, including associated adhesives and primers, that when installed create a protective envelope against water and wind.

***wetlands*:** those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. This definition incorporates all areas that would meet the definition of "*wetlands*" under applicable federal or state guidance, whether or not they are officially designated, delineated, or mapped, including man-made areas that are designed, constructed, or restored to include the ecological functions of natural *wetlands*.

yearly average day-night average sound levels: level of the time-mean-square A-weighted sound pressure averaged over a one-year period with ten decibles (dB) added to sound levels occurring in each night-time period from 2200 hours to 0700 hours, expressed in decibles.

3.3 Abbreviations and Acronyms

AC	alternating current
AHJ	*authority having jurisdiction*
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
BIFMA	The Business and Institutional Furniture Manufacturer's Association
BMS	Building Management System
BoD	*Basis of Design*
Btu	British thermal unit
Btu/h	British thermal unit per hour
CDPH	California Department of Public Health
CFC	chlorofluorocarbon
cfm	cubic feet per minute (ft^3/min)
CH_4	methane
ci	continuous insulation
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	carbon dioxide
CO_2e	*carbon dioxide equivalent*
CSA	Canadian Standards Association
CxA	*commissioning authority*
dB	decibel
db	dry bulb
DC	direct current
DCV	*demand control ventilation*
EISA	Energy Independence and Security Act
EMS	Energy Management System
EPAct	U.S. Energy Policy Act
EPD	environmental product declaration
ESC	erosion and sedimentation control
ET_c	*evapotranspiration*
ET_o	*maximum evapotranspiration*
ETS	environmental tobacco smoke
fc	footcandle
FF&E	furniture, fixtures, and equipment
ft	foot
gal	gallon

gpm	gallons per minute
GWP	global warming potential
h	hour
ha	hectare
HCFC	hydrochlorofluorocarbon
HVAC	heating, ventilation, and air conditioning
HVAC&R	heating, ventilation, air conditioning, and refrigeration
I-P	inch-pound
IA	Irrigation Association
IAPMO	International Association of Plumbing and Mechanical Officials
IAQ	indoor air quality
IEQ	indoor environmental quality
IES	Illuminating Engineering Society of North America
in.	inch
kg	kilogram
km	kilometre
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
L	litre
lb	pound
LCA	*life-cycle assessment*
LCI	life-cycle inventory
LPD	lighting power density
Ls	*liner system*
LZ	*lighting zone*
m	metre
µg	microgram
mg	milligram
MDF	medium density fiberboard
MERV	minimum efficiency reporting value
mi	mile
min	minute
mm	millimetre
mph	miles per hour
M&V	measurement and *verification*
N_2O	nitrous oxide
NA	not applicable
NAECA	National Appliance Energy Conservation Act
NR	not required
OITC	outdoor-indoor transmission class
O&M	operation and maintenance
OPR	*owner's project requirements*
Pa	Pascal
PF	*projection factor*
ppm	parts per million
s	second
SCAQMD	South Coast Air Quality Management District
SHGC	*solar heat gain coefficient*
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SRI	*solar reflectance index*
STC	sound transmission class
UL	Underwriters Laboratory
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFEMA	United States Federal Emergency Management Agency
USGBC	United States Green Building Council
VAV	*variable air volume*
VOC	volatile organic compound
VRF	variable refrigerant flow system
wb	wet bulb
WF	*water factor*
yr	year

4. ADMINISTRATION AND ENFORCEMENT

4.1 General. *Building projects* shall comply with Sections 4 through 11. Within each of those sections, *building projects* shall comply with all Mandatory Provisions (x.3) and, where offered, either the

a. Prescriptive Option (x.4) or
b. Performance Option (x.5).

4.1.1 Referenced Standards. The standards referenced in this standard and listed in Section 11 shall be considered part of the requirements of this standard to the prescribed extent of such reference. Where differences exist between provisions of this standard and a referenced standard, the provisions of this standard shall apply. Informative references in Informative Appendix G are cited to acknowledge sources and are not part of this standard.

4.1.2 Normative Appendices. The normative appendices to this standard are considered to be integral parts of the mandatory requirements of this standard, which for reasons of convenience are placed apart from all other normative elements.

4.1.3 Informative Appendices. The informative appendices to this standard and informative notes located within this standard contain additional information and are not mandatory or part of this standard.

5. *SITE* SUSTAINABILITY

5.1 Scope. This section addresses requirements for *building projects* that pertain to *site* selection, *site* development, mitigation of *heat island effect*, light pollution reduction, and mitigation of transportation impacts.

5.2 Compliance. All of the provisions of Section 5 are mandatory provisions.

5.3 Mandatory Provisions

5.3.1 *Site* Selection. The *building project* shall comply with Sections 5.3.1.1 and 5.3.1.2.

5.3.1.1 Allowable *Sites.* The *building project* shall take place in or on one of the following:

a. An existing *building envelope*.
b. A *brownfield site*.
c. A *greyfield site*.
d. A *greenfield site* that is within 1/2 mi (800 m) of *residential* land that is developed, or that has one or more buildings under construction, with an average density of ten *dwelling units* per acre (4 units per ha) unless that *site* is *agricultural land* or *forest land*. Proximity is determined by drawing a circle with a 1/2 mi (800 m) radius around the center of the proposed *site*.
e. A *greenfield site* that is within 1/2 mi (800 m) of not less than ten basic services and that has pedestrian access between the building and the services, unless that *site* is *agricultural land* or *forest land*. Basic services include but are not limited to (1) financial institutions, (2) places of worship, (3) convenience or grocery stores, (4) day care facilities, (5) dry cleaners, (6) fire stations, (7) beauty shops, (8) hardware stores, (9) laundry facilities, (10) libraries, (11) medical/dental offices, (12) senior care facilities, (13) parks, (14) pharmacies, (15) post offices, (16) restaurants, (17) schools, (18) supermarkets, (19) theaters, (20) community centers, (21) fitness centers, (22) museums, and (23) local government facilities. Proximity is determined by drawing a circle with a 1/2 mi (800 m) radius around the center of the proposed *site*.
f. A *greenfield site* that is either within 1/2 mi (800 m) of an existing or planned and funded commuter rail, *light rail*, or subway station, or within 1/4 mi (400 m) of *adequate transit service* usable by building occupants, unless that *site* is *agricultural land* or *forest land*. Proximity is determined by drawing a circle with a 1/2 mi (800 m) radius around the center of the proposed *site*.
g. A *greenfield site* that is *agricultural land*, and the building's purpose is related to the agricultural use of the land.
h. A *greenfield site* that is *forest land*, and the building's purpose is related to the forestry use of the land.
i. A *greenfield site* that is *designated park land*, and the building's purpose is related to the use of the land as a park.

5.3.1.2 Prohibited Development Activity. There shall be no *site* disturbance or development of the following:

a. Previously undeveloped land having an elevation lower than 5 ft (1.5 m) above the elevation of the 100-year flood, as defined by USFEMA.

Exceptions to 5.3.1.2(a):

1. Development of *low-impact trails* shall be allowed anywhere within a flood zone.
2. Development of building structures shall be allowed in alluvial "AO" designated flood zones, provided that such structures include engineered floodproofing up to an elevation that is at least as high as the minimum lowest floor elevation determined by the *authority having jurisdiction* (*AHJ*), and provided that the *site* includes drainage paths constructed to guide floodwaters around and away from the structures.

b. Land within 150 ft (50 m) of any *fish and wildlife habitat conservation area.*

Exceptions to 5.3.1.2(b):

1. Development of *low-impact trails* shall be allowed, provided that such trails are located at least 15 ft (4.5 m) from the area.
2. *Site* disturbance or development shall be allowed, provided that it involves plantings or habitat enhancement of the functions and values of the area.

c. Land within 100 ft (35 m) of any *wetland.*

Exceptions to 5.3.1.2(c):

1. Development of *low-impact trails* shall be allowed, provided that such trails are located at least 15 ft (4.5 m) from the *wetland*.
2. *Site* disturbance or development shall be allowed, provided that it involves plantings or habitat enhancement of the functions and values of the *wetland*.

5.3.2 Predesign *Site* Inventory and Assessment. A predesign inventory and assessment of the natural resources of the *building project site* shall be submitted with the *site* design and *construction documents*. The inventory and assessment shall include all of the following:

a. Location of any prohibited development areas identified in Section 5.3.1.2 that are located on or adjacent to the *building project site*.
b. Identification of *invasive plant* species on the *site*.
c. Identification of *native plant* species on the *site*.
d. Identification of *site* features designated for preservation.

5.3.3 Plants

5.3.3.1 *Invasive Plants.* *Invasive plants* shall be removed from the *building project site* and destroyed or disposed of in a land fill. *Invasive plants* shall not be planted on the *building project site*.

5.3.4 Stormwater Management. Stormwater management systems shall be provided on the building *site*. Except to the extent that other stormwater management approaches are required by a local, state, or federal jurisdiction, these systems shall be limited to one or more of the following management methods:

a. Infiltration
b. *Evapotranspiration*
c. Rainwater harvesting
d. Stormwater collection and use

5.3.4.1 Projects on *Greenfield Sites*. Projects on *greenfield sites* shall comply with at least one of the following:

a. Stormwater management systems shall retain on site no less than the volume of precipitation during a single 24 h period equal to the 95th percentile precipitation event. *Building projects* with stormwater management systems that are designed to retain volumes greater than that of the 98th percentile precipitation event shall conduct a hydrologic analysis of the building *site* to determine the water balance of the *site* prior to its development, clearing, and filling and to demonstrate that the stormwater management system will not cause ecological impairment by starving receiving waters downstream of the *site*.
b. The stormwater management system design shall maintain *site* water balance (the combined runoff, infiltration, and *evapotranspiration*) based on a hydrologic analysis of the *site*'s conditions prior to development, clearing, and filling. Postconstruction runoff rate, volume, and duration shall not exceed rates preceding development, clearing, or filling of the *site*.

5.3.4.2 Projects on *Greyfield Sites.* Projects on *greyfield sites* shall retain on site no less than the volume of precipitation during a single 24 h period equal to or greater than the 60th percentile precipitation event.

Exception: Where any fraction of the 60th percentile precipitation event cannot be retained, that fraction shall be treated to limit total suspended solids to 25 mg/L in the remaining discharge.

5.3.4.3 Discharge Rate. *Building project sites* shall be designed and constructed to comply with one of the following requirements:

a. The discharge of the design storm shall occur over a period of not less than 48 h.
b. The discharge flow duration curve at any point in time shall be plus or minus 10% of the flow duration curve for channel-forming discharges for the *site* prior to its development, clearing, or filling.

5.3.4.4 Adjoining Lots. The stormwater management system shall direct or concentrate off-site discharge to avoid increased erosion or other drainage-related damage to adjoining *lots* or public property.

5.3.4.5 Discharges from Contaminated Soils. Stormwater management systems on areas of *brownfield sites* where contaminated soils are left in place shall not use infiltration practices that will result in pollutant discharges to groundwater**.** Stormwater discharge from *brownfield sites* shall be treated to limit total suspended solids to 25 mg/L. Stormwater management systems shall not penetrate, damage, or otherwise compromise remediation actions at the building *site*.

5.3.4.6 Coal Tar Sealants. The use of tar sealants shall be prohibited in any application exposed to stormwater, wash waters, condensates, irrigation water, snowmelt, or icemelt.

5.3.5 Mitigation of *Heat Island Effect*

5.3.5.1 *Site* Hardscape. At least 50% of the *site hardscape* that is not covered by *solar energy systems* shall be provided with one or any combination of the following:

a. Existing trees and vegetation or new *biodiverse plantings* of *native plants* and *adapted plants*, which shall be planted either prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.
b. Paving materials with a minimum initial *solar reflectance index* (*SRI*) of 29. A default *SRI* value of 35 for new concrete without added color pigment is allowed to be used instead of measurements.
c. *Open-graded (uniform-sized) aggregate*, *permeable pavement*, *permeable pavers*, and *porous pavers (open-grid pavers)*. *Permeable pavement* and *permeable pavers* shall have a percolation rate of not less than 2 gal/min·ft^2 (100 L/min·m^2).
d. Shading through the use of structures, provided that the top surface of the shading structure complies with the provisions of Section 5.3.5.3.
e. Parking under a building, provided that the *roof* of the building complies with the provisions of Section 5.3.5.3.
f. Buildings or structures that provide shade to the *site hardscape*. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

Exception to 5.3.5.1: Section 5.3.5.1 shall not apply to *building projects* in *Climate Zones* 6, 7, and 8.

5.3.5.2 *Walls*. Above-grade building *walls* and retaining *walls* shall be shaded in accordance with this section. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Compliance with this section shall be achieved through the use of shade-providing *plants*, manmade structures, existing buildings, hillsides, permanent building projections, *on-site renewable energy systems*, or a combination of these, using the following criteria:

a. Shade shall be provided on at least 30% of the east and west above-grade *walls* and retaining *walls* from grade level to a height of 20 ft (6 m) above grade or the top of the exterior *wall*, whichever is less. Shade coverage shall be calculated at 10 a.m. for the east *walls* and 3 p.m. for the west *walls* on the summer solstice.
b. Where shading is provided by vegetation, such vegetation shall be existing trees and vegetation or new *biodiverse plantings* of *native plants* and *adapted plants.* Such planting shall occur prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. Vegetation shall be appropriately sized, selected, planted, and maintained so that it does not interfere with overhead or underground utilities. Trees shall be placed a minimum of 5 ft (1.5 m) from and within 50 ft (15 m) of the building or retaining *wall*.

Exceptions to 5.3.5.2:

1. The requirements of this section are satisfied if 75% or more of the opaque *wall* surfaces on the east and west have a minimum *SRI* of 29. Each *wall* is allowed to be considered separately for this exception.
2. East *wall* shading is not required for buildings located in *Climate Zones* 5, 6, 7, and 8. West *wall* shading is not required for buildings located in *Climate Zones* 7 and 8.

5.3.5.3 *Roofs*. This section applies to the building and covered parking *roof* surfaces for *building projects* in *Climate Zones* 1, 2, and 3. A minimum of 75% of the entire *roof* surface not used for *roof* penetrations and associated equipment; *on-site renewable energy systems*, such as photovoltaics or solar thermal energy collectors, including necessary *space* between rows of panels or collectors; portions of the *roof* used to capture heat for building energy technologies; rooftop decks or walkways; or vegetated (green) roofing systems shall be covered with products that

a. have a minimum three-year-aged *SRI* of 64 for a low-sloped *roof*. A low-sloped *roof* has a slope of less than or equal to 2:12.
b. have a minimum three-year-aged *SRI* of 15 for a steep-sloped *roof*. A steep sloped *roof* has a slope of more than 2:12.

Exceptions to 5.3.5.3:

1. *Building projects* where an annual energy analysis simulation demonstrates that the total annual building energy cost and total annual CO_2e, as calculated in accordance with Sections 7.5.2 and 7.5.3, are both a minimum of 2% less for the proposed *roof* than for a *roof* material complying with the requirements of Section 5.3.5.3(a).
2. *Roofs* used to shade or cover parking and *roofs* over *semiheated spaces*, provided that they have a minimum initial *SRI* of 29. A default *SRI* value of 35 for new concrete without added color pigment is allowed to be used instead of measurements.

5.3.5.4 *Solar Reflectance Index (SRI)*. The *SRI* shall be calculated in accordance with ASTM E1980 for medium-speed wind conditions using a convection coefficient of 2.1 Btu/h·ft^2·°F (11.9 W/m^2·°C) for the following conditions:

a. For materials other than *roofs*, the *SRI* shall be based upon solar reflectance, as measured in accordance with ASTM E1918 or ASTM C1549, and the thermal emittance, as measured in accordance with ASTM E408 or ASTM C1371. The values for solar reflectance and thermal emittance shall be determined and certified by an independent third party.
b. For roofing products, the *SRI* values shall be based on a minimum three-year-aged solar reflectance and thermal emittance, as measured in accordance with the CRRC-1 standard, and shall be certified by the manufacturer.

5.3.6 Reduction of Light Pollution

5.3.6.1 General. Exterior lighting systems shall comply with Sections 9.1, 9.4.1.4, 9.4.2, 9.4.3, and 9.7 of ANSI/ASHRAE/IES Standard 90.1 and with Sections 5.3.6.2 and 5.3.6.3 of this standard.

5.3.6.2 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 5.3.6.2A.
b. All other luminaires shall meet the maximum allowable Backlight and Glare Ratings in Table 5.3.6.2B.

5.3.6.3 Uplight. All exterior lighting shall meet one of the following uplight requirements:

a. Exterior luminaires shall meet the maximum allowable Uplight Ratings of Table 5.3.6.2B.
b. Exterior lighting shall meet the Uplight requirements of Table 5.3.6.3.

Exceptions to 5.3.6.3:

1. Lighting in *Lighting Zones* 3 and 4, solely for uplighting structures, building façades, or landscaping.
2. Lighting in *Lighting Zones* 1 and 2, solely for uplighting structures, building façades, or landscaping, provided the applicable lighting power densities do not exceed 50% of the *lighting power allowances* in ANSI/ASHRAE/IES Standard 90.1, Table 9.4.2-2.

Exceptions to 5.3.6.2 and 5.3.6.3:

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.

5.3.7 Mitigation of Transportation Impacts

5.3.7.1 Pedestrian and Transit Connectivity

5.3.7.1.1 Walkways. Each *primary building entrance* shall be provided with a pedestrian walkway that extends to either a *public way* or a transit stop. Walkways across parking lots shall be clearly delineated.

5.3.7.2 Bicycle Parking

5.3.7.2.1 Minimum Number of *Spaces*. Bicycle parking *spaces* shall be provided for at least five percent of the

TABLE 5.3.6.2A Maximum Allowable Glare Ratings for Building-Mounted Luminaires Within Two Mounting Heights of Any Property Line[a,b]

Distance in Mounting Heights to Nearest Property Line	*LZ0*	*LZ1*	*LZ2*	*LZ3*	*LZ4*
≥1 and <2	G0	G0	G1	G1	G2
≥0.5 and <1	G0	G0	G0	G1	G1
<0.5	G0	G0	G0	G0	G1

a. For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 feet (1.5 m) beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section

b. Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

TABLE 5.3.6.2B Maximum Allowable Backlight, Uplight, and Glare (BUG) Ratings[a,b,c,d]

	LZ0	*LZ1*	*LZ2*	*LZ3*	*LZ4*
Allowed Backlight Rating					
>2 mounting heights from property line	B1	B3	B4	B5	B5
1 to 2 mounting heights from property line	B1	B2	B3	B4	B4
0.5 to 1 mounting height to property line	B0	B1	B2	B3	B3
<0.5 mounting height to property line	B0	B0	B0	B1	B2
Allowed Uplight Rating	U0	U1	U2	U3	U4
Allowed Glare Rating	G0	G1	G2	G3	G4

a. Except where installed on a building surface, luminaires that are located at a distance of two times the mounting height of the luminaire or less from a property line shall have the backlight of the luminaire aimed towards and perpendicular to the nearest property line. Backlight is that part of the luminaire's lumen output that was used to determine the backlight rating in its final angular position.

b. For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 feet (1.5 m) beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section.

c. If the luminaire is installed in other than the intended manner, or is an adjustable luminaire for which the aiming is specified, the rating shall be determined by the actual photometric geometry in the aimed orientation.

d. Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

TABLE 5.3.6.3 Maximum Allowable Percentage of Uplight

	LZ0	*LZ1*	*LZ2*	*LZ3*	*LZ4*
Percentage of total exterior fixture lumens allowed to be emitted above 90 degrees or higher from nadir (straight down)	0%	0%	1%	2%	5%

occupant load of each building but not less than two parking *spaces*. Occupants who are nonambulatory, under restraint, or under custodial care need not be included in the total *occupant load* for the building. *Building projects* with *dwelling units* shall be provided with at least 0.5 bicycle parking *spaces* per bedroom for each building but not less than two parking *spaces*.

Exceptions:

1. *Building projects* with *dwelling units* that provide each unit with a private garage or private locked storage *space* of sufficient size to store a bicycle.
2. The number of bicycle parking *spaces* shall be allowed to be reduced subject to *AHJ* approval of a transportation plan, prepared by a *design professional*, that demonstrates the likelihood that building occupants will use public transportation and/or walk to the *building project site*.

5.3.7.2.2 Location. Not fewer than two bicycle parking *spaces* shall be located within 50 ft (15.2 m) of, and be visible from, the *building entrance* being served. All other bicycle parking *spaces* shall be located inside the building, or the nearest point of the bicycle parking area(s) shall be within 50 ft (15.2 m) of the *building entrance* being served. Bicycle parking shall not obstruct pedestrian access to the building.

5.3.7.2.3 Horizontal Parking Racks. Horizontal bicycle parking racks shall provide a *space* for each bicycle that is not less than 18 in. (305 mm) in width and not less than 72 in. (1829 mm) in length. Each *space* shall provide at least two points of contact between the bicycle frame and rack. Each *space* shall have access to a clear exit pathway not less than 36 in. (914 mm) in width.

5.3.7.2.4 Ability to Lock. Each bicycle parking *space* shall be provided with a securely mounted rack or other facilities for locking or securing a bicycle. A rack shall allow the