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.

CONTENTS

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:

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

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*.

5.3.3.2 Greenfield Sites. On a *greenfield site*

a. where more than 20% of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum of 20% of the area of *native plants* or *adapted plants* shall be retained.
b. where 20% or less of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum of 20% of the *site* shall be developed or retained as vegetated area. Such vegetated areas include bioretention facilities, rain gardens, filter strips, grass swales, vegetated

level spreaders, constructed *wetlands*, planters, and open space with plantings. A minimum of 60% of such vegetated area shall consist of *biodiverse planting* of *native plants* and/or *adapted plants* other than *turfgrass*.

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.

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%

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 *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 locking of the frame and the front or rear wheel of the bicycle to the rack using a U-shaped shackle lock.

5.3.7.2.5 Security and Visibility. All bicycle parking *spaces* shall be visible from the entrance being served; secured in a locker, cage or room; or provided with valet service or security cameras. Signage shall be provided to identify parking that is not visible from the *building entrance*.

5.3.7.2.6 Documentation. *Construction documents* shall include plans and details showing compliance with Sections 5.3.7.2.1 through 5.3.7.2.5.

5.3.7.3 *Site* Vehicle Provisions. Where on-site vehicle parking is provided for a building that has a building *occupant load* greater than 100, at least one of the following shall be provided:

a. **Provisions for preferred parking *spaces*.** At least five percent of the parking *spaces* provided shall be designated as preferred parking for vehicles that meet both the minimum greenhouse gas and air pollution scores as required for USEPA SmartWay designation. Preferred parking *spaces* shall be located on the shortest route of travel from the parking facility to a *building entrance* but shall not take precedence over parking *spaces* that are required to be accessible for individuals with disabilities. Where buildings have multiple entrances with adjacent parking, parking *spaces* shall be dispersed and located near the entrances. Such parking *spaces* shall be provided with signage approved by the *AHJ* that specifies the permitted usage.
b. **Provisions for electric vehicle charging infrastructure.** Two or more electric vehicle charging systems shall be available to the building occupants and shall be located no more than 1/4 mi (400 m) from the *building project*.

6. WATER USE EFFICIENCY

6.1 Scope. This section specifies requirements for *potable water* and *nonpotable water* use efficiency, both for the *site* and for the building, and water monitoring.

6.2 Compliance. The water systems shall comply with Section 6.3, "Mandatory Provisions," and either

a. Section 6.4, "Prescriptive Option," or
b. Section 6.5, "Performance Option."

Site water use and building water use are not required to use the same option, i.e., prescriptive or performance, for demonstrating compliance.

6.3 Mandatory Provisions

6.3.1 *Site* Water Use Reduction

6.3.1.1 Landscape Design. A minimum of 60% of the area of the *improved landscape* shall be in *biodiverse planting* of *native plants* and *adapted plants* other than *turfgrass*.

Exception: The area of dedicated athletic fields, golf courses, and driving ranges shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas, or public recreational facilities.

6.3.1.2 Irrigation System Design. *Hydrozoning* of *automatic* irrigation systems to water different plant materials, such as *turfgrass* versus shrubs, is required. Landscaping sprinklers shall not be permitted to spray water directly on a building or within 3 ft (1 m) of a building.

6.3.1.3 Controls. Any irrigation system for the project *site* shall be controlled by a qualifying *smart controller* that uses *evapotranspiration* (*ET*) and weather data to adjust irrigation schedules and that complies with the minimum requirements or an on-site rain or moisture sensor that automatically shuts the system off after a predetermined amount of rainfall or sensed moisture in the soil. Qualifying *smart controllers* shall meet the minimum requirements, as listed below, when tested in accordance with IA *SWAT* Climatological-Based Controllers 8th Draft Testing Protocol. *Smart controllers* that use *ET* shall use the following inputs for calculating appropriate irrigation amounts:

a. *Irrigation adequacy*—80% minimum ET_c.
b. *Irrigation excess*—not to exceed 10%.

Exception to 6.3.1.3: A temporary irrigation system used exclusively for the establishment of new landscape shall be exempt from this requirement. Temporary irrigation systems shall be removed or permanently disabled at such time as the *landscape establishment period* has expired.

6.3.2 Building Water Use Reduction

6.3.2.1 Plumbing Fixtures and Fittings. Plumbing fixtures (water closets and urinals) and fittings (faucets and showerheads) shall comply with the following requirements, as shown in Table 6.3.2.1:

a. **Water closets (toilets)—flushometer valve type.** For single-flush, maximum flush volume shall be determined in accordance with ASME A112.19.2/CSA B45.1 and shall not exceed 1.28 gal (4.8 L). For dual-flush, the full-flush volume shall not exceed 1.28 gal (4.8 L) per flush. Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.
b. **Water closets (toilets)—tank-type.** Tank-type water closets shall be certified to the performance criteria of the USEPA WaterSense Tank-Type High-Efficiency Toilet Specification and shall have a maximum full-flush volume of 1.28 gal (4.8 L). Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.
c. **Urinals.** Maximum flush volume when determined in accordance with ASME A112.19.2/CSA B45.1—0.5 gal (1.9 L). Flushing urinals shall comply with the performance criteria of the USEPA WaterSense Specification for Flushing Urinals. Nonwater urinals shall comply with ASME A112.19.19 (vitreous china) or IAPMO Z124.9 (plastic) as appropriate.
d. **Public lavatory faucets.** Maximum flow rate—0.5 gpm (1.9 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1.
e. **Public metering self-closing faucet.** Maximum water use—0.25 gal (1.0 L) per metering cycle when tested in accordance with ASME A112.18.1/CSA B125.1.
f. ***Residential* bathroom lavatory sink faucets.** Maximum flow rate—1.5 gpm (5.7 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* bathroom lavatory sink faucets shall comply with the performance criteria of the USEPA WaterSense High-Efficiency Lavatory Faucet Specification.
g. ***Residential* kitchen faucets.** Maximum flow rate—1.8 gpm (6.8 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. Kitchen faucets shall be permitted to temporarily increase the flow greater than 1.8 gpm (6.8 L/min) but shall not exceed 2.2 gpm (8.3 L/min) and must automatically revert to the established maximum flow rate of 1.8 gpm (6.8 L/min) upon physical release of the activation mechanism or closure of the faucet valve.
h. ***Residential* showerheads.** Maximum flow rate—2.0 gpm (7.6 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* showerheads shall comply with the performance requirements of the USEPA WaterSense Specification for Showerheads.
i. ***Residential* shower compartment (stall) in *dwelling units* and guest rooms.** The allowable flow rate from all shower outlets (including rain systems, waterfalls, bodysprays, and jets) that can operate simultaneously shall be limited to a total of 2.0 gpm (7.6 L/min).

Exception to 6.3.2.1(i): Where the area of a shower compartment exceeds 2600 in.^{2} (1.7 m^2), an additional flow of 2.0 gpm (7.6 L/min) shall be permitted for each multiple of 2600 in.^{2} (1.7 m^2) of floor area or fraction thereof.

6.3.2.2 Appliances

a. Clothes washers and dishwashers installed within *dwelling units* shall comply with the ENERGY STAR® Program Requirements for Clothes Washers and ENERGY STAR Program Requirements for Dishwashers. Maximum water use shall be as follows:

TABLE 6.3.2.1 Plumbing Fixtures and Fittings Requirements

Plumbing Fixture	Maximum
Water closets (toilets)—flushometer single-flush valve type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—flushometer dual-flush valve type	Full-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—single-flush tank-type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—dual-flush tank-type	Effective dual-flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate—0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate—1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate—1.8 gpm (6.8 L/min)*
Residential showerheads	Flow rate—2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in *dwelling units* and guest rooms	Flow rate from all shower outlets total of 2.0 gpm (7.6 L/min)

* With provision for a temporary override to 2.2 gpm (8.3 L/min) as specified in Section 6.3.2.1(g).

1. Clothes washers—Maximum *water factor* of 5.4 gal/ft^3 of drum capacity (0.72 L/L of drum capacity).
2. Dishwashers—Standard-size dishwashers shall have a maximum *water factor* of 3.8 gal/full operating cycle (14.3 L/full operating cycle). Compact sizes shall have a maximum *water factor* of 3.5 gal/full operating cycle (13.2 L/full operating cycle). Standard and compact size shall be defined by ENERGY STAR criteria.

(See also the energy efficiency requirements in Section 7.4.7.3.)

b. Clothes washers installed in publicly accessible *spaces* (e.g., multifamily and hotel common areas) and coin- and card-operated clothes washers of any size used in laundromats shall have a maximum *water factor* of 4.0 gal/ft^3 of drum capacity-normal cycle (0.53 L/L of drum capacity-normal cycle). (See also the energy efficiency requirements in Sections 7.4.7.3).
c. Commercial dishwashers in commercial food-service facilities shall meet all ENERGY STAR requirements as listed in the Version 2.0 ENERGY STAR Program Requirements for Commercial Dishwashers.

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 6.3.3A. 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 shall be recovered for reuse.

6.3.2.4 *Roofs*

a. The use of *potable water* or *reclaimed water* for *roof* spray systems to thermally condition the *roof* shall be prohibited.

Exception to 6.3.2.4(a): Where approved by the *authority having jurisdiction* (*AHJ*), on-site treated *reclaimed water* may be used for *roof* spray systems.

b. Inground irrigation systems on vegetated *roofs* using potable or off-site treated *reclaimed water* shall be prohibited.
c. The use of *potable water* or *reclaimed water* for irrigation of vegetated (green) *roofs* is prohibited after vegetation establishment period or 18 month after the initial installation, whichever is less. After the landscape *plants* are established, the irrigation system using *potable water* or *reclaimed water* shall be removed from *site*.

Exception to 6.3.2.4(c): Where approved by the *AHJ*, on-site treated *reclaimed water* may be used for vegetated *roof* irrigation systems during and after the vegetation establishment period.

6.3.3 Water Consumption Measurement

6.3.3.1 Consumption Management. Measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building. Both potable and *reclaimed water* entering the *building project* shall be monitored or submetered. In addition, for individual leased, rented, or other tenant or subtenant *space* within any building totaling in excess of 50,000 ft^2 (5000 m^2), separate submeters shall be provided. For subsystems with multiple similar units, such as multicell cooling towers, only one measurement device is required for the subsystem. Any project

TABLE 6.3.3A Subsystem Water Measurement Thresholds

Subsystem	Submetering Threshold
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower >500 gpm (30 L/s)
Evaporative coolers	Makeup water >0.6 gpm (0.04 L/s)
Steam and hot-water boilers	>500,000 Btu/h (50 kW) input
Total irrigated landscape area with controllers	>25,000 ft^2 (2500 m^2)
Separate campus or project buildings	Consumption >1000 gal/day (3800 L/day)
Separately leased or rental *space*	Consumption >1000 gal/day (3800 L/day)
Any large water-using process	Consumption >1000 gal/day (3800 L/day)

TABLE 6.3.3B Water Supply Source Measurement Thresholds

Water Source	Main Measurement Threshold
Potable water	1000 gal/day (3800 L/day)
Municipally *reclaimed water*	1000 gal/day (3800 L/day)
Alternate sources of water	500 gal/day (1900 L/day)

or building, or tenant or subtenant *space* within a project or building, such as a commercial car wash or aquarium, shall be submetered where consumption is projected to exceed 1000 gal/day (3800 L/day).

Measurement devices with remote capability shall be provided to collect water use data for each water supply source (e.g., *potable water*, *reclaimed water*, rainwater) to the *building project* that exceeds the thresholds listed in Table 6.3.3A. Utility company service entrance/interval meters are allowed to be used.

Provide submetering with remote communication measurement to collect water use data for each of the building subsystems if such subsystems are sized above the threshold levels listed in Table 6.3.3B.

6.3.3.2 Consumption Data Collection. All building measurement devices, monitoring systems, and submeters installed to comply with the thresholds limits in Section 6.3.3.1 shall be configured to communicate water consumption data to a meter data management system. At a minimum, meters shall provide daily data and shall record hourly consumption of water.

6.3.3.3 Data Storage and Retrieval. The meter data management system shall be capable of electronically storing water meter, monitoring systems, and submeter data and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device and submeter and provide alarming notification capabilities as needed to support the requirements of the Water User Efficiency Plan for Operation in Section 10.3.2.1.2.

6.4 Prescriptive Option

6.4.1 *Site* Water Use Reduction. For golf courses and driving ranges, only municipally *reclaimed water* and/or *alternate on-site sources of water* shall be used to irrigate the landscape. For other landscaped areas, a maximum of one-third of *improved landscape* area is allowed to be irrigated with *potable water*. The area of dedicated athletic fields shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas, or public recreational facilities. All other irrigation shall be provided from *alternate on-site sources of water* or municipally *reclaimed water*.

Exception: *Potable water* is allowed to be temporarily used on such newly installed landscape for the *landscape establishment period*. The amount of *potable water* that may be applied to the newly planted areas during the temporary *landscape establishment period* shall not exceed 70% of ET_o for *turfgrass* and 55% of ET_o for other plantings. If municipally *reclaimed water* is available at a water main within 200 ft (60 m) of the project *site*, it shall be used in lieu of *potable water* during the *landscape establishment period*. After the *landscape establishment period* has expired, all irrigation water use shall comply with the requirements established elsewhere in this standard.

6.4.2 Building Water Use Reduction

6.4.2.1 Cooling Towers. The water being discharged from cooling towers for air-conditioning systems, such as chilled-water systems, shall be limited in accordance with method (a) or (b):

a. For make-up waters having less than 200 ppm (200 mg/L) of total hardness expressed as calcium carbonate, by achieving a minimum of five *cycles of concentration.*
b. For make-up waters with more than 200 ppm (200 mg/L) of total hardness expressed as calcium carbonate, by achieving a minimum of 3.5 *cycles of concentration*.

Exception to 6.4.2.1: Where the total dissolved solids concentration of the discharge water exceeds 1500 mg (1500 ppm/L), or the silica exceeds 150 ppm (150 mg/L) measured as silicon dioxide before the above *cycles of concentration* are reached.

6.4.2.2 Commercial Food Service Operations. Commercial food service operations (e.g., restaurants, cafeterias, food preparation kitchens, caterers, etc.)

a. shall use high-efficiency prerinse spray valves (i.e., valves that function at 1.3 gpm (4.9 L/min) or less and comply with a 26-second performance requirement when tested in accordance with ASTM F2324);

b. shall use dishwashers that comply with the requirements of the ENERGY STAR Program for Commercial Dishwashers;
c. shall use boilerless/connectionless food steamers that consume no more than 2.0 gal/hour (7.5 L/hour) in the full operational mode;
d. shall use combination ovens that consume not more than 10 gal/hour (38 L/hour) in the full operational mode;
e. shall use air-cooled ice machines that comply with the requirements of the ENERGY STAR Program for Commercial Ice Machines; and
f. shall be equipped with hands-free faucet controllers (foot controllers, sensor-activated, or other) for all faucet fittings within the food preparation area of the kitchen and the dish room, including pot sinks and washing sinks.

6.4.2.3 Medical and Laboratory Facilities. Medical and laboratory facilities, including clinics, hospitals, medical centers, physician and dental offices, and medical and nonmedical laboratories of all types shall use all of the following:

a. Only water-efficient steam sterilizers equipped with (1) water-tempering devices that allow water to flow only when the discharge of condensate or hot water from the sterilizer exceeds 140°F (60°C) and (2) mechanical vacuum equipment in place of venturi-type vacuum systems for vacuum sterilizers.
b. Film processor water recycling units where large frame x-ray films of more than 6 in. (150 mm) in either length or width are processed (small dental x-ray equipment is exempt from this requirement).
c. Digital imaging and radiography systems where the digital networks are installed.
d. A dry-hood scrubber system, or, if the applicant determines that a wet-hood scrubber system is required, the scrubber shall be equipped with a water recirculation system. For perchlorate hoods and other applications where a hood wash-down system is required, the hood shall be equipped with self-closing valves on those wash-down systems.
e. Only dry vacuum pumps, unless fire and safety codes for explosive, corrosive, or oxidative gasses require a liquid ring pump.
f. Only efficient water treatment systems that comply with the following criteria:
    1. For all filtration processes, pressure gages shall determine and display when to backwash or change cartridges.
    2. For all ion exchange and softening processes, recharge cycles shall be set by volume of water treated or based upon conductivity or hardness.
    3. For reverse osmosis and nanofiltration equipment, with capacity greater than 27 gal/h (100 L/h), reject water shall not exceed 60% of the feed water and shall be used as scrubber feed water or for other beneficial uses on the project *site*.
    4. Simple distillation is not acceptable as a means of water purification.
g. Food service operations within medical facilities shall comply with Section 6.4.2.2.

6.4.3 Special Water Features. Water use shall comply with the following:

a. Ornamental fountains and other ornamental water features shall be supplied either by *alternate on-site sources of water* or by municipally *reclaimed water* delivered by the local water utility acceptable to the *AHJ*. Fountains and other features shall be equipped with (1) makeup water meters, (2) leak detection devices that shut off water flow if a leak of more than 1.0 gal/h (3.8 L/h) is detected, and (3) equipment to recirculate, filter, and treat all water for reuse within the system.

Exception to 6.4.3(a): Where *alternate on-site sources of water* or municipally *reclaimed water* are not available within 500 ft (150 m) of the *building project site*, *potable water* is allowed to be used for water features with less than 10,000 gallon (38,000 L) capacity.

b. Pools and spas
    1. Backwash water: Recover filter backwash water for reuse on landscaping or other applications, or treat and reuse backwash water within the system.
    2. Filtration: For filters with removable cartridges, only reusable cartridges and systems shall be used. For filters with backwash capability, use only pool filter equipment that includes a pressure drop gage to determine when the filter needs to be backwashed, and a sight glass enabling the operator to determine when to stop the backwash cycle.
    3. Pool splash troughs, if provided, shall drain back into the pool system.

6.5 Performance Option. Calculations shall be made in accordance with *generally accepted engineering standards* and handbooks acceptable to the *AHJ*.

6.5.1 *Site* Water Use Reduction. *Potable water* (and municipally *reclaimed water*, where used) intended to irrigate *improved landscape* shall be limited to 35% of the water demand for that landscape. The water demand shall be based upon *ET* for that climatic area and shall not exceed 70% of ET_o for *turfgrass* areas and 55% of ET_o for all other plant material after adjustment for rainfall.

6.5.2 Building Water Use Reduction. The *building project* shall be designed to have a total annual interior water use less than or equal to that achieved by compliance with Sections 6.3.2, 6.4.2, and 6.4.3.

7. ENERGY EFFICIENCY

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

7.2 Compliance. The energy systems shall comply with Section 7.3, "Mandatory Provisions," and either

a. Section 7.4, "Prescriptive Option," or
b. Section 7.5, "Performance Option."

7.3 Mandatory Provisions

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

7.3.1.1 *Continuous Air Barrier*. The exceptions to the requirement for a *continuous air barrier* in Section 5.4.3.1 of ANSI/ASHRAE/IES Standard 90.1 for specific *climate zones* and constructions shall not apply.

7.3.2 *On-Site Renewable Energy Systems*. *Building project* design shall show allocated *space* and pathways for future installation of *on-site renewable energy systems* and associated infrastructure that provide the annual energy production equivalent of not less than 6.0 kBtu/ft^2 (20 kWh/m^2) for single-story buildings and not less than 10.0 kBtu/ft^2 (32 kWh/m^2) multiplied by the *gross roof area* in ft^2 (m^2) for all other buildings.

Exceptions:

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

7.3.3 Energy Consumption Management

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

For all buildings that exceed the threshold in Table 7.3.3.1A, subsystem measurement devices with remote capability (including current sensors or flowmeters) shall be provided to measure energy consumption data of each subsystem for each use category that exceeds the thresholds listed in Table 7.3.3.1B.

The energy consumption data from the subsystem measurement devices shall be automatically communicated to the data acquisition system.

7.3.3.2 Energy Consumption Data Collection. All building measurement devices shall be configured to automatically communicate the energy data to the data acquisition system. At a minimum, measurement devices shall provide daily data and shall record hourly energy profiles. Such hourly energy profiles shall be capable of being used to assess building performance at least monthly.

TABLE 7.3.3.1A Energy Source Thresholds

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

7.3.3.3 Data Storage and Retrieval. The data acquisition system shall be capable of electronically storing the data from the measurement devices and other sensing devices for a minimum of 36 months and creating user reports showing hourly, daily, monthly, and annual energy consumption.

Exception: Portions of buildings used as *residential.*

7.4 Prescriptive Option

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

7.4.1.1 *On-Site Renewable Energy Systems*. *Building projects* shall comply with either the Standard Renewables Approach in Section 7.4.1.1.1 or the Alternate Renewables Approach in Section 7.4.1.1.2

7.4.1.1.1 Standard Renewables Approach: Baseline *On-Site Renewable Energy Systems.* *Building projects* shall contain *on-site renewable energy systems* that provide the annual energy production equivalent of not less than 6.0 kBtu/ft^2 (20 kWh/m^2) multiplied by the *gross roof area* in ft^2 (m^2) for single-story buildings, and not less than 10.0 kBtu/ft^2 (32 kWh/m^2) multiplied by the *gross roof area* in ft^2 (m^2) for all other buildings. The annual energy production shall be the combined sum of all *on-site renewable energy systems.*

Exceptions: Buildings that demonstrate compliance with both of the following are not required to contain *on-site renewable energy systems*:

1. An annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 4.0 kWh/m^2·day (1.2 kBtu/ft^2/day), accounting for existing buildings, permanent infrastructure that is not part of the *building project*, topography, and trees.
2. A commitment to purchase renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity Products of at least 7 kWh/ft^2 (75 kWh/m^2) of *conditioned space* each year until the cumulative purchase totals 70 kWh/ft^2 (750 kWh/m^2) of *conditioned space*.

TABLE 7.3.3.1B System Energy Use Thresholds

Use (Total of All Loads)	Subsystem Threshold
HVAC system	Connected electric load > 100kVA
HVAC system	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA Connected gas or district services load > 250,000 Btu/h (75 kW)

7.4.1.1.2 Alternate Renewables Approach: Reduced *On-Site Renewable Energy Systems* and Higher-Efficiency Equipment. *Building projects* complying with this approach shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the water-heating efficiency requirements in Section 7.4.4.1, equipment efficiency requirements in Section 7.4.7.1, and the applicable ENERGY STAR® requirements in Section 7.4.7.3.2, and shall contain *on-site renewable energy systems* that provide the annual energy production equivalent of not less than 4.0 kBtu/ft^2 (13 kWh/m^2) multiplied by the *gross roof area* in ft^2 (m^2) for single-story buildings, and not less than 7.0 kBtu/ft^2 (22 kWh/m^2) multiplied by the *gross roof area* in ft^2 (m^2) for all other buildings. The annual energy production shall be the combined sum of all *on-site renewable energy systems.* For equipment listed in Section 7.4.7.3.2 that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both requirements.

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

7.4.2.1 *Building Envelope* Requirements. The *building envelope* shall comply with the requirements in Tables 5.5-1 through 5.5-8 of ANSI/ASHRAE/IES Standard 90.1, with the following modifications to values in each table. For the opaque elements, each U-factor, C-factor, and F-factor in Tables 5.5-4 through 5.5-8 shall be reduced by ten percent. The "Insulation Min. R-Value" column in Tables 5.5-4 through 5.5-8 of ANSI/ASHRAE/IES Standard 90.1 shall not apply. For *vertical fenestration*, each U-factor shall be reduced by ten percent. For east-oriented and west-oriented *vertical fenestration*, each *solar heat gain coefficient* (*SHGC*) in Tables 5.5-4 through 5.5-8 shall be reduced by ten percent.

Informative Notes:

1. U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix A.
2. Section 5.3.5.3 of this standard includes additional provisions related to *roofs*.

Exceptions:

1. The U-factor, C-factor, or F-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1 Tables 5.5-4 through 5.5-8.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1 Tables 5.5-4 through 5.5-8.
3. *Spaces* that meet the requirements of Section 8.4.1, regardless of *space* area, are exempt from the *SHGC* criteria for *skylights*.

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

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

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

7.4.2.5 Permanent Projections. For *Climate Zones* 1 through 5, the *vertical fenestration* on the west, south, and east shall be shaded by permanent projections that have an area-weighted average *projection factor* (*PF*) of not less than 0.50. 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.

TABLE 7.4.2.6 *SHGC* Multipliers for Permanent Projections

PF	*SHGC* Multiplier (All Other Orientations)	*SHGC* Multiplier (*North-Oriented*)
0–0.60	1.00	1.00
>0.60–0.70	0.92	0.96
>0.70–0.80	0.84	0.94
>0.80–0.90	0.77	0.93
>0.90–1.00	0.72	0.90

b. Interior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position and have a minimum solar reflectance of 0.50 for the surface facing the *fenestration*.

c. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than four hours.

d. Acceptance testing and commissioning shall be conducted as required by 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 visible transmittance (VT) no greater than 0.05, and highest labeled VT no less than 0.40.

b. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than 4 hours.

c. Acceptance testing and commissioning shall be conducted as required by Section 10 to verify that *automatic* controls for *dynamic glazing* respond to changes in illumination or radiation intensity.

7.4.2.6 *SHGC* of *Vertical Fenestration*. For *SHGC* compliance, the methodology in Exception (2) to Section 5.5.4.4.1 of ANSI/ASHRAE/IES Standard 90.1 is allowed, provided that the *SHGC* multipliers in Table 7.4.2.6 of this standard are used. This requirement supersedes the requirement in Table 5.5.4.4.1 of ANSI/ASHRAE/IES Standard 90.1. Table 5.5.4.4.1 of ANSI/ASHRAE/IES Standard 90.1 shall not apply. *Vertical fenestration* that is *north oriented* shall be allowed to have a maximum *SHGC* of 0.10 greater than that specified in Tables 5.5-1 through 5.5-8 of ANSI/ASHRAE/IES Standard 90.1. When this provision is utilized, separate calculations shall be performed for these sections of the *building envelope*, and these values shall not be averaged with any others for compliance purposes.

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

7.4.2.8 Orientation. The *vertical fenestration* shall comply with either (a) or (b):

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

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

where

$SHGC_x$ = the *SHGC* for orientation *x* that complies with Section 7.4.2.6

$SHGC_C$ = the *SHGC* criteria for each *climate zone* from Section 7.4.2.1

A_x = *fenestration area* for orientation *x*

N = north (oriented less than 45 degrees of true north)

S = south (oriented less than 45 degrees of true south)

E = east (oriented less than or equal to 45 degrees of true east)

W = west (oriented less than or equal to 45 degrees of true west)

Exceptions:

1. *Vertical fenestration* that complies with the exception to Section 5.5.4.4.1(c) of ANSI/ASHRAE/IES Standard 90.1.
2. Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).
3. Alterations and additions with no increase in *vertical fenestration area*.
4. Buildings where the west-oriented and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades and the *SHGC* on those façades is not greater than 90% of the criteria in Section 7.4.2.1.
5. Buildings in *Climate Zone* 8.

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

7.4.3.1 Minimum Equipment Efficiencies for the Alternate Renewables Approach. All *building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 7.4.7.3.2.

7.4.3.2 Ventilation Controls for *Densely Occupied Spaces*. The requirements in this section supersede those in

TABLE 7.4.3.3 Minimum System Size for which an Economizer is Required

Climate Zones	Cooling Capacity for which an Economizer is Required[a]
1A, 1B	No economizer requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥33,000 Btu/h (9.7 kW)[a]

a. Where economizers are required, the total capacity of all systems without economizers shall not exceed 480,000 Btu/h (140 kW) per building or 20% of the building's air economizer capacity, whichever is greater.

Section 6.4.3.8 of ANSI/ASHRAE/IES Standard 90.1. *Demand control ventilation* (*DCV*) shall be provided for *densely occupied spaces* served by systems with one or more of the following:

a. An air-side economizer.
b. *Automatic* modulating control of the *outdoor air* dampers.
c. A design *outdoor airflow* greater than 1000 cfm (500 L/s).

Exceptions to 7.4.3.2:

1. Systems with exhaust air energy recovery complying with Section 7.4.3.6.
2. Systems with a design *outdoor airflow* less than 750 cfm (375 L/s).
3. *Spaces* where more than 75% of the *space* design *outdoor airflow* is utilized as *makeup air* or *transfer air* to provide *makeup air* for other *space*(*s*).
4. *Spaces* with one of the following occupancy categories as defined in ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbers; beauty and nail salons; and bowling alleys (*seating*).

The *DCV* system shall be designed to be in compliance with Section 6.2.7 of ANSI/ASHRAE Standard 62.1. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV*. All CO_2 sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

a. *Spaces* with CO_2 sensors or air-sampling probes leading to a central CO_2 monitoring station shall be provided with at least one sensor or probe for each 10,000 ft^2 (1000 m^2) of floor *space*. Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.
b. CO_2 sensors must be accurate to ±50 ppm at 1000 ppm.
c. *Outdoor air* CO_2 concentrations shall be determined by one of the following:
   1. *Outdoor air* CO_2 concentrations shall be dynamically measured using a CO_2 sensor.
   2. When documented statistical data are available on the local ambient CO_2 concentrations, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.
d. Occupant CO_2 generation rate assumptions shall be shown in the design documents.

7.4.3.3 Economizers. Systems shall include economizers meeting the requirements in Section 6.5.1 of ANSI/ASHRAE/IES 90.1 except as modified by the following:

a. The minimum size requirements for economizers for comfort cooling and for computer rooms are defined in Table 7.4.3.3 and supersede the requirements in Table 6.5.1 of ANSI/ASHRAE/IES Standard 90.1 as defined in Tables 6.5.1-1 and 6.5.1-2.
b. Rooftop units with a capacity of less than 54,000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h (16 kW) shall comply with the staging requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1
c. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume* [*VAV*] systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

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

a. Where the reduced renewable approach defined in Section 7.4.1.1.1 is used, Exception (9) to Section 6.5.1 of ANSI/ASHRAE/IES Standard 90.1 shall be permitted to eliminate the economizer requirement, provided the requirements in Table 6.5.1-3 of ANSI/ASHRAE/IES Standard 90.1 are applied to the efficiency requirements required by Section 7.4.1.1.2. If the standard renewable approach is chosen as defined in Section 7.4.1.1.1 then the requirements in Table 6.5.1-3 of ANSI/ASHRAE/IES Standard 90.1 shall be applied to the efficiency requirements in ANSI/ASHRAE/IES Standard 90.1 Tables 6.8.1-1 through 6.8.1-11.
b. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

7.4.3.4 Zone Controls. The exceptions to Section 6.5.2.1 of ANSI/ASHRAE/IES Standard 90.1 shall be modified as follows:

a. Exception (1) shall not be used.
b. Exception (2)(a)(2) shall be replaced by the following text: "the design *outdoor airflow* rate for the zone."

7.4.3.5 Fan System Power and Efficiency

7.4.3.5.1 Fan System Power Limitation. Systems shall have fan power limitations 10% below limitations specified in Table 6.5.3.1-1 of ANSI/ASHRAE/IES Standard 90.1. This

TABLE 7.4.3.7 Maximum Net Exhaust Flow Rate in cfm per Linear Foot of Hood Length

Type of Hood	Light-Duty Equipment	Medium-Duty Equipment	Heavy-Duty Equipment	Extra Heavy-Duty Equipment
Wall-mounted canopy	140	210	280	385
Single island[a]	280	350	420	490
Double island (per side)	175	210	280	385
Eyebrow	175	175	Not allowed	Not allowed
Backshelf/Passover	210	210	280	Not allowed

a. The total exhaust flow rate for all single-island hoods in a kitchen/dining facility shall be no more than 5000 cfm.

requirement supersedes the requirement in Section 6.5.3.1 and Table 6.5.3.1-1 of ANSI/ASHRAE/IES Standard 90.1. All exceptions in Section 6.5.3.1 of ANSI/ASHRAE/IES Standard 90.1 shall apply.

7.4.3.5.2 Fan Efficiency. The fan-efficiency requirements defined in Section 6.5.3.1.3 of ANSI/ASHRAE/IES Standard 90.1 shall be used, except that the total efficiency of the fan at the design point of operation shall be within ten percentage points of the maximum total efficiency of the fan. All exceptions in Section 6.5.3.1.3 of ANSI/ASHRAE/IES Standard 90.1 shall apply.

7.4.3.6 Exhaust Air Energy Recovery. The exhaust air energy recovery requirements defined in Section 6.5.6.1 of ANSI/ASHRAE/IES Standard 90.1, including the requirements in Tables 6.5.6.1-1 and 6.5.6.1-2, shall be used except that the energy recovery effectiveness shall not be less than 60%, superseding the 50% effectiveness requirement in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.5.1.

7.4.3.7 Kitchen Exhaust Systems. The requirements in Sections 6.5.7.1, 6.5.7.2, and 6.5.7.5 of ASHRAE/ANSI/IES Standard 90.1 shall apply, except as follows: Sections 7.4.3.7.1 and 7.4.3.7.2 supersede the requirements in Sections 6.5.7.1.3 and 6.5.7.1.4 of ANSI/ASHRAE/IES Standard 90.1.

7.4.3.7.1 For kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm, the maximum exhaust flow rate for each hood shall be determined in accordance with Table 7.4.3.7. For single hoods, or hood sections installed over appliances with different duty ratings, the maximum allowable exhaust flow rate for the hood or hood section shall be determined in accordance with Table 7.4.3.7 for the highest appliance duty rating under the hood or hood section. Refer to ASHRAE Standard 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

Exception: When at least 75% of all the replacement air is *transfer air* that would otherwise be exhausted.

7.4.3.7.2 Kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm shall comply with at least one of the following:

a. At least 50% of all replacement air must be *transfer air* that would otherwise be exhausted.
b. At least 75% of kitchen hood exhaust air shall be controlled by a demand ventilation system(s), which shall
    1. be capable of reducing exhaust and replacement air system airflow rates by no more than the larger of
        i. 50% of total design exhaust and replacement air system airflow rate or
        ii. the *outdoor airflow* and exhaust rates required to meet the ventilation and exhaust requirements of Sections 6.2 and 6.5 of ANSI/ASHRAE Standard 62.1 for the zone;
    2. include controls to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent, and combustion products during cooking and idle;
    3. include controls that result in full flow when the demand ventilation system(s) fail to modulate airflow in response to appliance operation; and
    4. allow occupants to temporarily override the system(s) to full flow.
c. Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40% shall be applied on at least 50% of the total exhaust airflow.
d. In *Climate Zones* 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 8B, when *makeup air* is uncooled or cooled without the use of *mechanical cooling*, the capacity of any nonmechanical *cooling* system(s) (for example, natural cooling or evaporative cooling) shall be demonstrated to be no less than the system capacity of a *mechanical cooling* system(s) necessary to meet the same loads under design conditions.

7.4.3.8 Duct Insulation. Duct insulation shall comply with the minimum requirements in Tables A-2 and A-3 in Normative Appendix A. These requirements supersede the requirements in Tables 6.8.2-1 and 6.8.2-2 of ANSI/ASHRAE/IES Standard 90.1.

7.4.3.9 *Automatic* Control of HVAC and Lights in Hotel/Motel Guest Rooms. In hotels and motels with over 50 guest rooms, *automatic controls* for the lighting, switched outlets, television, and HVAC equipment serving each guest room shall be configured according to the following requirements.

7.4.3.9.1 Lighting and Switched Outlet Control. Within 30 minutes of all occupants leaving the guest room, power for lighting and switched outlets shall be automatically turned off.

7.4.3.9.2 Television Control. Within 30 minutes of all occupants leaving the guest room, televisions shall be automatically turned off or placed in sleep or standby mode.

7.4.3.9.3 HVAC Setpoint Control. Within 30 minutes of all occupants leaving the guest room, HVAC setpoints shall be automatically raised by at least 5°F (3°C) from the occupant setpoint in the cooling mode and automatically lowered by at least 5°F (3°C) from the occupant setpoint in the heating mode. When the guest room is unrented and unoccupied, HVAC setpoints shall be automatically reset to 80°F (27°C) or higher in the cooling mode and to 60°F (16°C) or lower in the heating mode. Unrented and unoccupied guest rooms shall be determined by either of the following criteria:

a. The guest room has been continuously unoccupied for up to 16 hours.
b. A *networked guest-room control system* indicates the guest room is unrented and the guest room is unoccupied for no more than 30 minutes.

Exception to 7.4.3.9.3:

1. A *networked guest-room control system* may return the thermostat setpoints to their default setpoints 60 minutes prior to the time the room is scheduled to be occupied.
2. Cooling for humidity control shall be permitted during unoccupied periods.

7.4.3.9.4 Ventilation Control. Within 30 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall be automatically turned off, or *isolation devices* serving each guest room shall automatically shut off the supply of *outdoor air* to the room and shut off exhaust air from the guest room. In conjunction with the *automatic* ventilation shutoff, an *automatic* preoccupancy purge cycle shall provide *outdoor air* ventilation as specified in Section 8.3.1.6.

7.4.3.9.5 *Automatic* Control. Captive keycard systems shall not be used to comply with Section 7.4.3.9.

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

7.4.4.1 Equipment Efficiency for the Alternate Renewables Approach. All *building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Table B-9 in Normative Appendix B and the applicable ENERGY STAR requirements in Section 7.4.7.3.2. These requirements supersede the requirements in Table 7.8 of ANSI/ASHRAE/IES Standard 90.1.

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

7.4.5 Power. The power shall comply with Section 8 of ANSI/ASHRAE/IES Standard 90.1 with the following modifications and additions.

7.4.5.1 Peak Load Reduction. *Building projects* shall contain *automatic* systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand of the building by not less than 10% of the projected peak demand. Standby power generation shall not be used to achieve the reduction in peak demand.

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

Exception: *Building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 and containing *automatic* systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand by not less than 5% of the projected peak demand.

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

7.4.6.1 *Lighting Power Allowance*

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

a. For those areas where the Building Area Method is used, the LPD from Table 9.5.1 of ANSI/ASHRAE/IES Standard 90.1 shall be multiplied by the corresponding LPD Factor from Table 7.4.6.1A.
b. For those areas where the Space-by-Space Method is used, the LPD from Table 9.6.1 of ANSI/ASHRAE/IES Standard 90.1 shall be multiplied by the corresponding LPD Factor from Table 7.4.6.1B.
c. Control factors from Table 9.6.3 in ANSI/ASHRAE/IES Standard 90.1 shall not be used for any control methodologies required in this standard.

7.4.6.1.2 Exterior LPDs. The exterior *lighting power allowance* shall be determined using Section 9.4.3 of ANSI/ASHRAE/IES Standard 90.1 with the following modification. The LPDs from Table 9.4.2-2 of ANSI/ASHRAE/IES Stan-

TABLE 7.4.6.1B Lighting Power Density (LPD) Factors When Using the Space-by-Space Method

Common *Space* Types	
***Space* Type**	**LPD Factor**
Audience *seating* area	
… in an auditorium	1.00
… in a convention center	1.00
… in a gymnasium	0.85
… in a motion picture theater	1.00
… in a penitentiary	1.00
… in a performing arts theater	1.00
… in a religious building	1.00
… in a sports arena	1.00
… in all other audience *seating* areas	1.00
Classroom/lecture hall/training room	
… in a penitentiary	1.00
… in all other *classrooms*/lecture halls/training rooms	0.85
Conference/meeting/multipurpose room	0.90
Corridor	
… in a facility for the visually impaired (and used primarily by residents)	1.00
… in a hospital	1.00
… in a manufacturing facility	1.00
… in all other corridors	0.85
Courtroom	0.85
Dining area	
… in a penitentiary	1.00
… in a facility for the visually impaired (and used primarily by residents)	1.00
… in bar/lounge or leisure dining	1.00
… in cafeteria or fast food dining	1.00
… in family dining	0.85
… in all other dining areas	0.90
Laboratory	
… in or as a *classroom*	1.00
… in all other laboratories	0.95
Laundry/washing area	0.95
Lobby	
… in a facility for the visually impaired (and used primarily by residents)	1.00
… for an elevator	0.85
… in a hotel	1.00
… in a motion picture theater	0.95
… in a performing arts theater	1.00
… all other lobbies	0.95
Lounge/breakroom	
… in a healthcare facility	0.85
… in all other lounge/breakrooms	0.85

Common *Space* Types	
***Space* Type**	**LPD Factor**
Office	
… enclosed	0.95
… open plan	0.85
Sales area	0.95
All other common *space* types	1.00
Building-Type Specific *Space* Types	
***Space* Type**	**LPD Factor**
Convention center —Exhibit *space*	0.85
Gymnasium/fitness center	
… in an exercise area	0.85
… in a playing area	1.00
Healthcare facility	
… in an exam/treatment room	0.85
… in an imaging room	1.00
… in a medical supply room	0.90
… in a nursery	0.85
… in a nurse's station	0.90
… in an operating room	1.00
… in a patient room	0.90
… in a physical therapy room	0.85
… in a recovery room	1.00
Library	
… in a reading area	1.00
… in the stacks	0.95
Manufacturing facility	
… in a detailed manufacturing area	1.00
… in an equipment room	1.00
… in an extra high bay area	1.00
… in a high bay area	0.85
… in a low bay area	0.85
Transportation facility	
… in a baggage/carousel area	0.90
… in an airport concourse	0.90
… at a terminal ticket counter	0.85
Warehouse—Storage area	
… for medium to bulky, palletized items	0.85
… for smaller, hand-carried items	1.00
All other building-type specific *space* types	1.00

TABLE 7.4.6.1C *Lighting Power Allowance* Factors

	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

dard 90.1 shall be multiplied by the appropriate LPD Factor from Table 7.4.6.1C

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

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

7.4.6.3 *Automatic* Controls for Egress and Security Lighting. Lighting in any area within a building that is required to be continuously illuminated for reasons of building security or emergency egress shall not exceed 0.1 W/ft^2 (1 W/m^2). Additional egress and security lighting shall be allowed, provided it is controlled by an *automatic* control device that turns off the additional lighting.

7.4.6.4 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 7.4.6.5.1 or 7.4.6.5.2.

Exceptions:

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

7.4.6.4.1 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.

7.4.6.4.2 All other sign lighting shall include the following:

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.
b. Controls to automatically turn off during *daylight hours.*

7.4.6.5 Parking Lighting. This section supersedes Section 9.4.1.4 of ANSI/ASHRAE/IES Standard 90.1 for lighting serving uncovered parking areas. Outdoor luminaires serving uncovered parking areas shall be controlled by all of the following:

a. Luminaires shall be controlled by a device that automatically turns off the luminaire during *daylight hours*.
b. Luminaires shall be controlled by a timeclock or other control that automatically turns off the luminaire according to a timed schedule.
c. For luminaires having a rated input wattage of more than 50 W and where the bottom of the luminaire is mounted 24 ft (7.3 m) or less above the ground, the luminaires shall be controlled by one or more devices that automatically reduce lighting power of each luminaire by a minimum of 40% when there is no activity detected in the controlled zone for a period no longer than 15 minutes. No more than 1500 input watts of lighting power shall be controlled together.

Exceptions to 7.4.6.5(c):

1. Lighting serving uncovered parking areas does not include lighting for outdoor sales, including vehicle sales lots.
2. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

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

7.4.7.1 Equipment Efficiency for the Alternate Renewables Approach. All *building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 7.4.7.3.2.

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

a. 25% of the refrigeration system full-load total heat rejection.
b. 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. All *building projects* shall comply with the requirements in Section 7.4.7.3.1 and all *building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 shall also comply with Section 7.4.7.3.2.

7.4.7.3.1 ENERGY STAR Requirements for Equipment not Covered by Federal Appliance Efficiency Regulations (All *Building Projects*). The following equipment within the scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve

the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy:

a. Appliances
   1. Room air cleaners: ENERGY STAR Program Requirements for Room Air Cleaners
   2. Water coolers: ENERGY STAR Program Requirements for Water Coolers
b. Heating and Cooling
   1. Programmable thermostats: ENERGY STAR Program Requirements for Programmable Thermostats
   2. Ventilating fans: ENERGY STAR Program Requirements for *Residential* Ventilating Fans
c. *Electronics*
   1. Cordless phones: ENERGY STAR Program Requirements for Telephony
   2. Audio and video: ENERGY STAR Program Requirements for Audio and Video
   3. Televisions: ENERGY STAR Program Requirements for Televisions
   4. Set-top boxes: ENERGY STAR Program Requirements for Set-Top Boxes
d. Office Equipment
   1. Computers: ENERGY STAR Program Requirements for Computers
   2. Copiers: ENERGY STAR Program Requirements for Imaging Equipment
   3. Fax machines: ENERGY STAR Program Requirements for Imaging Equipment
   4. Laptops: ENERGY STAR Program Requirements for Computers
   5. Mailing machines: ENERGY STAR Program Requirements for Imaging Equipment
   6. Monitors: ENERGY STAR Program Requirements for Displays
   7. Multifunction devices (printer/fax/scanner): Program Requirements for Imaging Equipment
   8. Printers: ENERGY STAR Program Requirements for Imaging Equipment
   9. Scanners: ENERGY STAR Program Requirements for Imaging Equipment
   10. Computer servers: ENERGY Star Program Requirements for Computer Servers
e. Lighting
   1. Integral LED lamps: ENERGY STAR Program Requirements for Integral LED Lamps
f. Commercial Food Service
   1. Commercial fryers: ENERGY STAR Program Requirements for Commercial Fryers
   2. Commercial hot food holding cabinets: ENERGY STAR Program Requirements for Hot Food Holding Cabinets
   3. Commercial steam cookers: ENERGY STAR Program Requirements for Commercial Steam Cookers (see also water efficiency requirements in Section 6.4.2.2)
   4. Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers
   5. Commercial griddles: ENERGY STAR Program Requirements for Commercial Griddles
   6. Commercial ovens: ENERGY STAR Program Requirements for Commercial Ovens (see also water efficiency requirements in Section 6.4.2.2)

Exception to 7.4.7.3.1: Products with minimum efficiencies addressed in the Energy Policy Act (EPAct) and the Energy Independence and Security Act (EISA) when complying with Section 7.4.1.1.2.

7.4.7.3.2 ENERGY STAR Requirements for Equipment Covered by Federal Appliance Efficiency Regulations (Alternate Renewables Approach). For all *building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2, 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. For those products listed below that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both the requirements in this section and in Normative Appendix B.

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
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. *Residential* warm air furnaces: ENERGY STAR Program Requirements for Furnaces
   7. *Residential* geothermal heat pumps: ENERGY STAR Program Requirements for Geothermal Heat Pumps

c. Water Heaters: ENERGY STAR Program Requirements for *Residential* Water Heaters
d. Lighting
    1. Lamps: ENERGY STAR Program Requirements for Lamps (Light Bulbs)
    2. Luminaires: ENERGY STAR Program Requirements for Luminaires
    3. *Residential* light fixtures: ENERGY STAR Program Requirements for *Residential* Light Fixtures
e. Commercial Food Service
    1. Commercial refrigerators and freezers: ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers
    2. Commercial ice machines: ENERGY STAR Program Requirements for Commercial Ice Machines
f. 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

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

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

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

7.5 Performance Option

7.5.1 General Comprehensive Performance Requirements. Projects shall comply with either Section 7.5.2 or 7.5.3.

7.5.2 Performance Option A

a. **Annual Energy Cost.** The *proposed building performance* shall be equal to or less than the *baseline building performance* multiplied by one minus the percentage reduction in Table 7.5.2A using the Performance Rating Method in Normative Appendix G of ANSI/ASHRAE/IES Standard 90.1. *On-site renewable energy systems* in the *proposed design* shall be calculated using Table C.1(15) of Normative Appendix C. For mixed-use buildings, the percent reduction shall be determined by weighting each building type by floor area.
b. **Annual *Carbon Dioxide Equivalent* (CO_2e).** The *proposed design* shall have an annual CO_2e equal to or less than the annual CO_2e of the *baseline building design* multiplied by one minus the percentage reduction in Table 7.5.2A using the Performance Rating Method in Normative Appendix G of ANSI/ASHRAE/IES Standard 90.1. To determine the annual CO_2e for each energy source in the *baseline building design* and *proposed design*, the energy consumption shall be multiplied by the CO_2e emission factors from Table 7.5.2B.

TABLE 7.5.2A Performance Option A: Energy Cost and CO_2e Reductions

Building Type	Percent Reduction
Apartments	10%
Restaurants	5%
Lodging	12%
Semiheated Warehouses[a]	45%
Other[b]	24%

a. Conditioned warehouses shall use the "Other" category.
b. When the modeled energy use that is not *regulated energy use* exceeds 35% of the total *proposed building* energy use, the reduction shall be calculated using the following equation: Percent reduction = 0.55 – 0.99 × Percent Nonregulated Energy. The reduction shall be no lower than 5%.

TABLE 7.5.2B CO_2e Emission Factors

Building Project Energy Source	CO_2e, lb/kWh (kg/kWh)
Grid delivered electricity and other fuels not specified in this table	1.387 (0.630)
LPG or propane	0.600 (0.272)
Fuel oil (residual)	0.751 (0.341)
Fuel oil (distillate)	0.706 (0.320)
Coal	0.836 (0.379)
Gasoline	0.689 (0.313)
Natural gas	0.483 (0.219)
District chilled water	0.332 (0.151)
District steam	0.812 (0.368)
District hot water	0.767 (0.348)

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

7.5.3 Performance Option B

a. **Annual Energy Cost.** The *building project* shall have an annual energy cost less than or equal to that achieved by compliance with Sections 7.3 and 7.4, and Sections 5.3.4.2, 5.3.4.3, 6.3.2, 6.4.2, 8.3.1, and 8.4.1. Comparisons shall be made using Normative Appendix C.
b. **Annual *Carbon Dioxide Equivalent* (CO_2e).** The *building project* shall have an annual CO_2e less than or equal to that achieved by compliance with Sections 7.3 and 7.4, and Sections 5.3.4.2, 5.3.4.3, 6.3.2, 6.4.2, 8.3.1, and 8.4.1. Comparisons shall be made using Normative Appendix C. To determine the CO_2e value for each energy source in the *baseline building design* and *proposed design*, the energy consumption shall be multiplied by the emissions factor. CO_2e emission factors shall be taken from Table 7.5.2B.

8. INDOOR ENVIRONMENTAL QUALITY (IEQ)

8.1 Scope. This section specifies requirements for indoor environmental quality, including indoor air quality, environmental tobacco smoke control, *outdoor air* delivery monitoring, thermal comfort, *building entrances*, acoustic control, *lighting quality*, daylighting, and low-emitting materials.

8.2 Compliance. The indoor environmental quality shall comply with Section 8.3, "Mandatory Provisions," and either

a. Section 8.4, "Prescriptive Option," or
b. Section 8.5, "Performance Option."

Daylighting and low-emitting materials are not required to use the same option, i.e., prescriptive or performance, for demonstrating compliance.

8.3 Mandatory Provisions

8.3.1 Indoor Air Quality. The building shall comply with Sections 4 through 7 of ANSI/ASHRAE Standard 62.1 with the following modifications and additions. Health care facilities shall comply with the requirements of ANSI/ASHRAE/ASHE Standard 170. When a requirement is provided below, this supersedes the requirements in ANSI/ASHRAE Standard 62.1 or ANSI/ASHRAE/ASHE 170, whichever is applicable to the building.

8.3.1.1 Minimum Ventilation Rates. The Ventilation Rate Procedure of ANSI/ASHRAE Standard 62.1 shall be used. In health care facilities, the *minimum outdoor airflow rates* required by ANSI/ASHRAE/ASHE Standard 170 shall apply.

8.3.1.2 *Outdoor Air* Delivery Monitoring

8.3.1.2.1 System Design for *Outdoor Air* Intake Measurement. Each mechanical ventilation system shall be configured to allow for the measurement of the *outdoor air* intake for use in testing and balancing, recommissioning, and *outdoor air* monitoring as required in Section 8.3.1.2.2.

8.3.1.2.2 Monitoring Requirements. Each mechanical ventilation system shall have a *permanently installed* device to measure the *minimum outdoor airflow* that meets the following requirements:

a. The device shall employ methods described in ASHRAE Standard 111.
b. The device shall have an accuracy of ±10% of the *minimum outdoor airflow*. Where the *minimum outdoor airflow* varies, as in *demand control ventilation* systems, the device shall maintain this accuracy over the entire range of occupancy and system operation.
c. The device shall be capable of notifying the building operator, either by activating a local indicator or sending a signal to a building monitoring system, whenever an *outdoor air fault condition* exists. This notification shall require manual reset.

Exception to 8.3.1.2.2: Constant-volume air supply systems that do not employ *demand control ventilation* and that use an indicator to confirm that the intake damper is open to the position determined during system–startup and balancing, needed to maintain the design *minimum outdoor airflow*.

8.3.1.3 Filtration and Air Cleaner Requirements

a. **Particulate Matter.** The following requirements shall apply in all buildings.

Exception to 8.3.1.3(a): In health care facilities, the particulate filter requirements of ANSI/ASHRAE/ASHE Standard 170 shall apply.

1. **Wetted Surfaces.** Particulate matter filters or air cleaners having a minimum efficiency reporting value (MERV) of not less than 8 when rated in accordance with ANSI/ASHRAE Standard 52.2 shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an *occupiable space*. These requirements supersede the requirements in Section 5.8 of ANSI/ASHRAE Standard 62.1.
2. **Particulate Matter Smaller than 10 Micrometers (PM10).** Particulate matter filters or air cleaners shall be provided in accordance with Section 6.2.1.1 of ANSI/ASHRAE Standard 62.1 with the following modification. Such filters or air cleaners shall have a MERV of not less than 8 when rated in accordance with ANSI/ASHRAE Standard 52.2.
3. **Particulate Matter Smaller than 2.5 Micrometers (PM2.5).** Particulate matter filters or air cleaners shall be provided in accordance with Section 6.2.1.2 of ANSI/ASHRAE Standard 62.1 with the following modification. Such filters or air cleaners shall have a MERV of not less than 13 when rated in accordance with ANSI/ASHRAE Standard 52.2.

b. **Ozone.** Air cleaning devices for ozone shall be provided for buildings located in an area that is designated "nonattainment" with the National Ambient Air Quality Standards (NAAQS) for ozone as determined by the *authority having jurisdiction* (*AHJ*). Such air-cleaning devices shall have an ozone removal efficiency of no less than 40% where installed, operated, and maintained in accordance with the manufacturer recommendations. Such air-cleaning devices shall be operated whenever the outdoor ozone level is expected to exceed the NAAQS. This requirement supersedes the requirements of Section 6.2.1.3 of ANSI/ASHRAE Standard 62.1. This requirement applies to all buildings, including health care facilities covered by ANSI/ASHRAE/ASHE Standard 170.
c. **Sealing.** Where particulate matter filters or air cleaners are required by Section 8.3.1.3, filter tracks, filter supports, filters, and access doors shall be sealed in accordance with the following:

1. Where filter track and filter support systems incorporate multiple filters, the gap between each filter shall be sealed with a gasket and the gap between the filter and its track or support shall be sealed using gaskets that expand when the filter is removed. Filter support systems shall include a filter-to-support gasket *permanently installed* on the filter support, except for filter track and filter support systems that seal around the filter by means of a friction fit.

2. Filter tracks and filter supports shall be sealed to the HVAC equipment housing and ducts by a sealant or other sealing method.
3. Filter access doors shall be sealed to minimize filter bypass and air leakage into or out of the system.
4. Gaskets and seals used to comply with the requirements of this section shall be capable of effecting a seal for the anticipated life of the equipment, and the system shall be designed such that the seals are readily accessible.
5. Field- or shop-fabricated spacers shall not be installed for the purpose of replacing the intended size filter with a smaller size filter.

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.

8.3.1.5 Building Entrances. All *building entrances* shall employ an entryway floor system comprising a scraper surface, an absorption surface, and a finishing surface, in that order, in the direction of travel entering the building and in accordance with Sections 8.3.1.5.1, 8.3.1.5.2, and 8.3.1.5.3. Each surface shall be at least as wide as the entrance. The length shall be measured in the primary direction of travel.

Exceptions to 8.3.1.5:

1. Entrances to individual *dwelling units*.
2. Entrances that employ an entryway floor system that is not less than 4 ft (1.3 m) in length to provide access to *spaces* that are less than 3000 ft^2 (300 m^2) in area and that are not used as a pass-through to other parts of the building.
3. Doors the purpose of which is to meet code requirements for means of egress and not entry into the building.
4. Entrances that are locked for use by limited authorized personnel.

8.3.1.5.1 Scraper Surface. The scraper surface

a. shall be immediately outside, inside, or spanning the entry;
b. shall be a minimum of 3 ft (1 m) long; and
c. shall be constructed using materials that scrape away snow, dirt, and debris.

8.3.1.5.2 Absorption Surface. The absorption surface

a. shall be inside,
b. shall be a minimum of 3 ft (1 m) long, and
c. shall be constructed using materials that perform both a scraping action and a moisture wicking action.

8.3.1.5.3 Finishing Surface. The finishing surface

a. shall be a minimum of 4 ft (1.2 m) long and
b. shall be constructed using materials that capture particles and moisture.

8.3.1.6 Guest Room Preoccupancy *Outdoor Air* Purge Cycle. Guest room ventilation systems controlled according to Section 7.4.3.9.4 shall have an *automatic* preoccupancy purge cycle that shall provide *outdoor air* ventilation at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change. In guest rooms with a *networked guest room control system*, the purge cycle shall be completed within 60 minutes prior to the time the room is scheduled to be occupied. Where guest rooms are not connected to a *networked guest room control system*, the preoccupancy purge cycle shall occur daily.

8.3.1.7 Preoccupancy Ventilation Control. Ventilation systems serving zones that are not continuously occupied shall have controls designed to automatically provide *outdoor air* to the zones prior to their scheduled occupancy where the zones served by the ventilation system have been unoccupied for 24 hours or longer. This preoccupancy ventilation shall be provided continuously at the system design *minimum outdoor airflow* for a period of one hour prior to the expected occupancy, or at an *outdoor air* rate and for a time period that provides the same number of air changes as the design *minimum outdoor airflow* for one hour.

If the preoccupancy ventilation period requires ventilation earlier than as required by Section 6.4.3 of ANSI/ASHRAE/IES Standard 90.1, the preoccupancy ventilation start time of Section 8.3.1.7 shall take precedence.

Exception: Hotel and motel guest rooms subject to *automatic* control of HVAC and lighting as required in Sections 7 and 8.

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."

Exception: *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.

8.3.3 Acoustical Control

8.3.3.1 Exterior Sound. *Wall* and *roof*-ceiling assemblies that are part of the *building envelope* shall have a composite outdoor-indoor transmission class (OITC) rating of 40 or greater or a composite sound transmission class (STC) rating of 50 or greater, and *fenestration* that is part of the *building envelope* shall have an OITC or STC rating of 30 or greater for any of the following conditions:

a. Buildings within 1000 ft (300 m) of *expressways*.
b. Buildings within 5 mi (8 km) of airports serving more than 10,000 commercial jets per year.
c. Where *yearly average day-night average sound levels* at the property line exceed 65 dB.

Exception to 8.3.3.1: Buildings that may have to adhere to functional and operational requirements such as factories, stadiums, storage, enclosed parking structure, and utility buildings.

8.3.3.2 Interior Sound. Interior *wall* and floor/ceiling assemblies separating interior rooms and *spaces* shall be designed in accordance with all of the following:

a. *Wall* and floor-ceiling assemblies separating adjacent *dwelling units*, *dwelling units* and public *spaces*, adjacent tenant *spaces*, tenant *spaces* and public places, and adjacent *classrooms* shall have a composite STC rating of 50 or greater.
b. *Wall* and floor-ceiling assemblies separating hotel rooms, motel rooms, and patient rooms in nursing homes and hospitals shall have a composite STC rating of 45 or greater.
c. *Wall* and floor-ceiling assemblies separating *classrooms* from rest rooms and showers shall have a composite STC rating of 53 or greater.
d. *Wall* and floor-ceiling assemblies separating *classrooms* from music rooms, mechanical rooms, cafeteria, gymnasiums, and indoor swimming pools shall have a composite STC rating of 60 or greater.

8.3.3.3 Outdoor-Indoor Transmission Class (OITC) and Sound Transmission Class (STC). OITC values for assemblies and components shall be determined in accordance with ASTM E1332. STC values for assemblies and components shall be determined in accordance with ASTM E90 and ASTM E413.

8.3.4 Isolation of the Building from Pollutants in Soil. *Building projects* that include construction or expansion of a ground-level foundation and which are located on *brownfield sites* or in "Zone 1" counties identified to have a significant probability of radon concentrations higher than 4 picocuries/litre on the USEPA map of radon zones, shall have a *soil gas retarding system* installed between the newly constructed *space* and the soil.

8.3.5 *Lighting Quality*. The interior lighting and lighting controls shall be installed to meet the requirements of Sections 8.3.5.1 and 8.3.5.2.

8.3.5.1 Enclosed Office *Spaces*. Lighting for at least 90% of enclosed office *spaces* with less than 250 ft^2 (23.3 m^2) of floor area shall comply with at least one of the following:

a. Provide *multilevel lighting control*.
b. Provide *bilevel lighting control* and separate *task lighting*.

8.3.5.2 Multioccupant *Spaces*. Lighting for conference rooms, meeting rooms, multipurpose rooms, gymnasiums, auditoriums, ballrooms, cafeterias, *classrooms*, and other training or lecture rooms shall be provided with *multilevel lighting control*. Lighting settings or the lighting controlled by each manual control shall be labeled at the control device(s). The lighting in gymnasiums, auditoriums, ballrooms, and cafeterias shall also consist of at least two separately controlled groups of luminaires.

8.3.6 Moisture Control. Either a dynamic heat and moisture analysis in accordance with ASHRAE Standard 160 or steady-state water vapor transmission analysis in accordance with Sections 8.3.6.1 and 8.3.6.2 shall be performed on above-grade portions of the *building envelope* and on interior partitions as described in Section 8.3.6.2. Conditions conducive to condensate formation, as demonstrated by analysis, shall not occur at any location within the *building envelope* or partition components or on the interior side of surfaces not specifically designed and constructed to manage moisture.

Exception: Where analysis indicates that incidental condensate occurs in components engineered to allow or manage such condensate without damage to the *building envelope* components.

8.3.6.1 Exterior *Building Envelope*. The analysis shall be conducted using the average of at least ten consecutive years of weather data for the *outdoor air* temperature for the warmest three months of the year (summer condition) and the *outdoor air* temperature for the coldest three months of the year (winter condition). The analysis shall include all *building envelope* components, including interior *wall* finishes of the exterior *walls*.

8.3.6.2 Humid *Spaces*. A separate analysis shall be performed in *spaces* where process or occupancy requirements dictate dew-point conditions that are unique with respect to other *spaces* in the building, such as kitchens, water therapy rooms, swimming-pool enclosures, ice rink enclosures, shower rooms, locker rooms, operating rooms in health care facilities, and exhibit areas in museums.

8.3.6.2.1 For exterior *building envelope* components of humid *spaces*, the analysis shall use the *outdoor air* temperature conditions described in Section 8.3.6.1.

8.3.6.2.2 For *walls*, floors and ceilings between occupied *spaces* and adjacent *spaces*, the analysis shall be performed using design summer (cooling) conditions and design winter (heating) conditions of both types of *conditioned space*.

Exception: *Spaces* and their individual mechanical systems that are designed to control condensation and moisture accumulation in the adjacent *building envelope*, *walls*, or ceilings.

8.3.6.3 Flashing of *Fenestration*, Door Assemblies, Mechanical Equipment, and Other Penetrations of *Building Envelope*. Flashing or sealants shall be installed around *fenestration*, door assemblies, and penetrations associated with mechanical equipment and utility services, except where there is a mechanism for drainage to the outdoors or where the materials are designed for long-term contact with water.

8.4 Prescriptive Option

8.4.1 Daylighting

8.4.1.1 Daylighting in Large *Spaces* Directly under a *Roof* and Having High Ceilings. *Enclosed spaces*, including conditioned and unconditioned *spaces*, meeting all of the following criteria, shall comply with Sections 8.4.1.1.1, 8.4.1.1.2 and 8.4.1.1.3:

a. The *space* is in a building with three stories or fewer above grade.
b. The *space* area is greater than 2500 ft^2 (232 m^2).
c. The *space* is located directly under a *roof* and average ceiling heights are greater than 15 ft (4.6 m).

Exceptions to 8.4.1.1:

1. *Spaces* in buildings located in *Climate Zones* 7 or 8.
2. Auditoria, motion picture theaters, performing arts theaters, museums, places of worship, and refrigerated warehouses.
3. *Enclosed spaces* where documentation shows that existing structures or natural objects block direct sunlight on at least 50% of the *roof* over the *enclosed space* at all three of the following times on the date of the spring equinox: three hours before solar noon (peak solar altitude), at solar noon, and three hours after solar noon.

8.4.1.1.1 Minimum *Daylight Area*. A minimum of 50% of the floor area shall be in the *daylight area* as defined in Section 3. For the purposes of Section 8.4.1.1.1, the definition of *daylight area* shall be modified such that partitions and other obstructions that are less than the ceiling height are disregarded. *Daylight areas* shall be under *skylights*, under *roof monitors*, or in the primary or *secondary sidelighted areas* and shall meet at least one of the following requirements:

a. The combined area of the *skylights* within the *space* shall be no less than 3% of the calculated *daylight area under skylights*.
b. The *space* shall have a *skylight effective aperture* of at least 1%.
c. The combined area within the *space* of any *vertical fenestration* in *roof monitors* shall be no less than 20% of the calculated *daylight area under roof monitors*.
d. *Primary sidelighted areas* shall have a *sidelighting effective aperture* of no less than 0.15.
e. *Secondary sidelighted areas* shall have a *sidelighting effective aperture* of no less than 0.30.

8.4.1.1.2 Visible Transmittance (VT) of *Skylights* and *Roof Monitors*. The visible transmittance of *skylights* and *roof monitors* for *daylight areas* used to comply with Section 8.4.1.1.1 shall be no less than 0.40.

Exception: *Enclosed spaces* that have a *skylight effective aperture* of at least 1%.

8.4.1.1.3 *Skylight* Optical Diffusion Characteristics. *Skylights* used to comply with Section 8.4.1.1.1 shall have a glazing material or diffuser that has a measured haze value greater than 90%, tested according to ASTM D1003 or other test method approved by the *AHJ*.

Exceptions:

1. *Skylights* with a measured haze value less than or equal to 90% whose combined area does not exceed 5% of the total *skylight* area.
2. *Tubular daylighting devices* having a diffuser.
3. *Skylights* designed to prevent direct sunlight from entering the occupied *space* below during occupied hours.
4. *Skylights* in transportation terminals and concourses, sports arenas, convention centers, and shopping malls.

TABLE 8.4.1.2 Minimum *Sidelighting* Effective Aperture

Climate Zone	Minimum *Sidelighting* Effective Aperture
1, 2, 3A, 3B	0.10
3C, 4, 5, 6, 7, 8	0.15

8.4.1.2 Minimum *Sidelighting Effective Aperture* for Office *Spaces* and *Classrooms*. Office *spaces* and *classrooms* shall comply with the following criteria:

a. All north-, south-, and east-facing façades shall have a minimum *sidelighting effective aperture* as prescribed in Table 8.4.1.2.
b. For all façades, the combined width of the *primary sidelighted areas* shall be at least 75% of the length of the façade *wall*.
c. All opaque interior surfaces in *daylight areas* shall have average visible light reflectances greater than or equal to 80% for ceilings, 40% for partitions higher than 60 in. (1.5 m), and 60% for *walls*.

Exceptions to 8.4.1.2:

1. *Spaces* with tasks that requires dark conditions (e.g., photographic processing).
2. *Spaces* covered by and in compliance with Section 8.4.1.1 without use of any exception.
3. *Daylight areas* where the height of existing adjacent structures above the window is at least twice the distance between the window and the adjacent structures, measured from the top of the glazing.

8.4.1.3 Office *Space* Shading. Each west-, south-, and east-facing façade, shall be designed with a shading *projection factor* (*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 to 8.4.1.3:

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 *AHJ*, 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.

8.4.2 Materials. Reported emissions or volatile organic compound (VOC) contents specified in the following subsections shall be from a representative product sample and conducted with each product reformulation or at a minimum of every three years. Products certified under third-party certification programs as meeting the specific emission or VOC content requirements listed in the following subsections are exempted from this three-year testing requirement but shall meet all the other requirements as listed.

8.4.2.1 Adhesives and Sealants. Products in this category include carpet, resilient, and wood flooring adhesives; base cove adhesives; ceramic tile adhesives; drywall and panel adhesives; aerosol adhesives; adhesive primers; acoustical sealants; firestop sealants; HVAC air duct sealants; sealant primers; and caulks. All adhesives and sealants used on the interior of the building (defined as inside of the *weatherproofing system* and applied on site) shall comply with the requirements of either Section 8.4.2.1.1 or 8.4.2.1.2.

8.4.2.1.1 Emissions Requirements. Emissions shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces* regardless of the *space* type.

8.4.2.1.2 VOC Content Requirements. VOC content shall comply with and shall be determined according to the following limit requirements:

a. Adhesives, sealants and sealant primers: SCAQMD Rule 1168. HVAC duct sealants shall be classified as "Other" category within the SCAQMD Rule 1168 sealants table.
b. Aerosol adhesives: Section 3 of Green Seal Standard GS-36.

Exceptions to 8.4.2.1.2: The following solvent welding and sealant products are not required to meet the emissions or the VOC content requirements listed above.

1. Cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems.
2. HVAC air duct sealants when the air temperature of the *space* in which they are applied is less than 40°F (4.5°C).

8.4.2.2 Paints and Coatings. Products in this category include anticorrosive coatings, basement specialty coatings, concrete/masonry sealers, concrete curing compounds, dry fog coatings, faux finishing coatings, fire-resistive coatings, flat and nonflat topcoats, floor coatings, graphic arts (sign) coatings, high-temperature coatings, industrial maintenance coatings, low solids coatings, mastic texture coatings, metallic pigmented coatings, multicolor coatings, pretreatment wash primers, primers, reactive penetrating sealers, recycled coatings, shellacs (clear and opaque), specialty primers, stains, stone consolidants, swimming-pool coatings, tub- and tile-refining coatings, undercoaters, waterproofing membranes, wood coatings (clear wood finishes), wood preservatives, and zinc primers. Paints and coatings used on the interior of the building (defined as inside of the *weatherproofing system* and applied on-site) shall comply with either Section 8.4.2.2.1 or 8.4.2.2.2.

8.4.2.2.1 Emissions Requirements. Emissions shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces* regardless of the *space* type.

8.4.2.2.2 Volatile Organic Compound (VOC) Content Requirements. VOC content shall comply with and be determined according to the following limit requirements:

a. Flat and nonflat topcoats, primers, undercoaters, and anticorrosive coatings: Green Seal Standard GS-11.
b. Concrete/masonry sealers (waterproofing concrete/masonry sealers), concrete curing compounds, dry fog coatings, faux finishing coatings, fire resistive coatings, floor coatings, graphic arts (sign) coatings, industrial maintenance coatings, mastic texture coatings, metallic pigmented coatings, multicolor coatings, pretreatment wash primers, reactive penetrating sealers, recycled coatings, shellacs (clear and opaque), specialty primers, stains, wood coatings (clear wood finishes), wood preservatives, and zinc primers: California Air Resources Board Suggested Control Measure for Architectural Coatings or SCAQMD Rule 1113
c. Basement specialty coatings, high-temperature coatings, low solids coatings, stone consolidants, swimming-pool coatings, tub- and tile-refining coatings, and waterproofing membranes: California Air Resources Board Suggested Control Measure for Architectural Coatings

8.4.2.3 Floor Covering Materials. Floor covering materials installed in the building interior shall comply with the following:

a. Carpet: Carpet shall be tested in accordance with and shown to be compliant with the requirements of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350). Products that have been verified and labeled to be in compliance with Section 9 of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) comply with this requirement.
b. Hard surface flooring in office *spaces* and *classrooms*: Materials shall be tested in accordance with and shown to be compliant with the requirements of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350).

8.4.2.4 Composite Wood, Wood Structural Panel, and Agrifiber Products. Composite wood, wood structural panel, and agrifiber products used on the interior of the building (defined as inside of the *weatherproofing system*) shall contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins. Composite wood and agrifiber products

are defined as follows: particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Materials considered furniture, fixtures, and equipment (FF&E) are not considered base building elements and are not included in this requirement. Emissions for products covered by this section shall be determined according to and shall comply with one of the following:

a. Third-party certification shall be submitted indicating compliance with the California Air Resource Board's (CARB) regulation, *Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products*. Third-party certifier shall be approved by CARB.
b. CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces* regardless of the *space* type.

Exception to 8.4.2.4: Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for interior use.

8.4.2.5 *Office Furniture Systems* and *Seating*. *Office furniture systems* and *seating* installed prior to occupancy shall comply with the requirements of both Sections 8.4.2.5.1 and 8.4.2.5.2 based on testing according to ANSI/BIFMA M7.1.

8.4.2.5.1 At least 95% of the total number of installed *office furniture system* workstations and at least 95% of the total number of *seating* units installed shall comply with ANSI/BIFMA X7.1.

8.4.2.5.2 At least 50% of the total number of installed *office furniture system* workstations and at least 50% of the total number of *seating* units installed shall comply with Section 7.6.2 of ANSI/BIFMA e3.

8.4.2.6 Ceiling and *Wall* Systems. These systems include ceiling and *wall* insulation, acoustical ceiling panels, tackable *wall* panels, gypsum *wall* board and panels, and *wall* coverings. Emissions for these products shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces* regardless of the *space* type.

8.4.3 Lighting for Presentations. Luminaires that are located entirely or partially within 3 ft (0.9 m) horizontally of any *permanently installed* presentation surfaces, including whiteboards, blackboards, chalkboards, and screens for projection units, shall be controlled separately from all other luminaires in the *space* and be capable of being turned off. Control settings for these luminaires shall be labeled at the control device. At least one luminaire shall be located entirely or partially within 3 ft (0.9 m) horizontally of each *permanently installed* whiteboard, blackboard, or chalkboard that is not self-illuminated.

8.5 Performance Option

8.5.1 Daylighting Simulation

8.5.1.1 Usable Daylight Illuminance in Large *Spaces*. In buildings three stories and fewer above grade, *enclosed spaces*, including conditioned and unconditioned *spaces*, with floor area greater than 5000 ft^2 (465 m^2) directly under a *roof* with average ceiling heights greater than 15 ft (4.6 m) and with a *lighting power allowance* for general lighting equal to or greater than 0.5 W/ft^2 (5.4 W/m^2), a physical or computer model for the *building project* shall be used to demonstrate a calculated illuminance from daylight of no less than 25 fc (250 lux) at 9:00 a.m. and 3:00 p.m. on the date of the spring equinox for at least half of the *space*. Daylight illuminances resulting from a physical model or computer daylighting model are to be calculated for a plane 2.5 ft (0.8 m) above the floor and need not include storage racks or internal obstructions other than *walls* and permanent partitions. The simulation shall include daylight illuminance calculations with no more than 5 ft (1.5 m) between calculation points.

a. Computer models shall be built using daylight simulation software based on the ray-tracing or radiosity methodology.
b. Simulation and normalized physical model results shall be based on external daylight illuminance using either the CIE Overcast Sky Model or the CIE Clear Sky Model for the location of the project.
c. For office *spaces*, the same model (including shading) used to show compliance with Section 8.5.1.3 shall be used in the calculation of illuminances.

Exceptions to 8.5.1.1:

1. Buildings in *Climate Zones* 7 or 8.
2. Auditoria, motion picture theaters, performing arts theaters, museums, places of worship, and refrigerated warehouses.
3. *Enclosed spaces* where it is documented that existing structures or natural objects block direct beam sunlight on at least 50% of the *roof* over the *enclosed space* at all three of the following times on the date of the spring equinox: three hours before solar noon (peak solar altitude), at solar noon, and three hours after solar noon.

8.5.1.2 Usable Daylight Illuminance in Office *Spaces* and *Classrooms*. The physical or computer model for the *building project* shall demonstrate that at least 75% of the area within one ceiling height of the perimeter *walls* has a calculated daylight illuminance of at least 25 fc (250 lux) at 9:00 a.m. and 3:00 p.m. on the date of the spring equinox. The physical or computer daylighting model shall calculate daylight illuminance on a plane 2.5 ft (0.8 m) above the floor with no more than 5 ft (1.5 m) between calculation points. The simulation need not include storage racks or internal obstructions other than *walls* and permanent partitions.

a. Computer models shall use daylight simulation software based on the ray-tracing or radiosity methodology.
b. Simulation and normalized physical model results shall be based on external daylight illuminance using either the CIE Overcast Sky Model or the CIE Clear Sky Model for the location of the project.
c. For office *spaces*, the same model (including shading) used to show compliance with Section 8.5.1.3 shall be used in the calculation of illuminances.

Exceptions to 8.5.1.2:

1. *Spaces* with tasks that require dark conditions (e.g., photographic processing).
2. *Spaces* that are covered by and compliant with the requirements of Section 8.5.1.1 without using exceptions.
3. *Daylight areas* where the height of existing adjacent structures above the window is at least twice the distance between the window and the adjacent structures, measured from the top of the glazing.

8.5.1.3 Direct Sun Limitation on Worksurfaces in Offices. It shall be demonstrated that direct sun does not strike anywhere on a worksurface in any daylighted *space* for more than 20% of the occupied hours during an equinox day in regularly occupied office *spaces*. If the worksurface height is not defined, a height of 2.5 ft (0.75 m) above the floor shall be used.

8.5.2 Materials. The emissions of all the materials listed below and used within the building (defined as inside of the *weatherproofing system* and applied on-site) shall be modeled for individual VOC concentrations. The sum of each individual VOC concentration from the materials listed below shall be shown to be in compliance with the limits as listed in Section 4.3 of the CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall be compared to 100% of its corresponding listed limit. In addition, the modeling for the building shall include at a minimum the criteria listed in Normative Appendix D of this standard. Emissions of materials used for modeling VOC concentrations shall be obtained in accordance with the testing procedures of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) unless otherwise noted below.

a. Tile, strip, panel, and plank products, including vinyl composition tile, resilient floor tile, linoleum tile, wood floor strips, parquet flooring, laminated flooring, and modular carpet tile.
b. Sheet and roll goods, including broadloom carpet, sheet vinyl, sheet linoleum, carpet cushion, wallcovering, and other fabric.
c. Rigid panel products, including gypsum board, other *wall* paneling, insulation board, oriented strand board, medium density fiber board, wood structural panel, acoustical ceiling tiles, and particleboard.
d. Insulation products.
e. Containerized products, including adhesives, sealants, paints, other coatings, primers, and other "wet" products.
f. Cabinets, shelves, and worksurfaces that are permanently attached to the building before occupancy. Emissions of these items shall be obtained in accordance with the ANSI/BIFMA M7.1.
g. *Office furniture systems* and *seating* installed prior to initial occupancy. Emissions of these items shall be obtained in accordance with the ANSI/BIFMA M7.1.

Exception to 8.5.2: *Salvaged materials* that have not been refurbished or refinished within one year prior to installation.

8.5.3 Lighting for Presentations. Lighting systems shall be provided and shall be controllable by the occupant(s) so as to meet the illuminance and uniformity requirements specified in items (a) through (c) for each *permanently installed* presentation system. Lighting control settings required to meet each of the specified levels shall be labeled at the control device.

a. Lighting system and controls shall be capable of illuminating *permanently installed* white boards to at least an average of 300 lux vertical illuminance, and the ratio of average-to-minimum illuminance over the full area of the whiteboard shall be equal to or less than 3:1.
b. Lighting system and controls shall be capable of illuminating *permanently installed* screens for front-screen projection units to no greater than 50 lux vertical illuminance, and the ratio of maximum-to-average illuminance over the full area of the projection screen shall be equal to or less than 2:1. Compliance with this provision shall not be met by turning off all the luminaires in the *space*.
c. Lighting system and controls shall be capable of illuminating *permanently installed* screens for rear-screen projection units at a level no greater than 150 lux vertical illuminance, and the ratio of maximum-to-average illuminance over the full area of the projection screen shall be equal to or less than 2:1. Compliance with this provision shall not be met by turning off all the luminaires in the *space*.

9. THE BUILDING'S IMPACT ON THE ATMOSPHERE, MATERIALS, AND RESOURCES

9.1 Scope. This section specifies requirements for the building's impact on the atmosphere, materials, and resources, including construction waste management, refrigerants, storage and collection of recyclables, and reduced impact materials.

9.2 Compliance. The building materials shall comply with Section 9.3, "Mandatory Provisions," and either

a. Section 9.4, "Prescriptive Option," or
b. Section 9.5, "Performance Option."

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 reuse, recycling, repurposing, and/or composting. Excavated soil and land-clearing debris shall not be included in the waste diversion calculation. *Alternative daily cover* and waste-to-energy incineration shall not be included as diverted material. All diversion calculations shall be based on either weight or volume, but not both, throughout the construction process.

Informative Note: Reuse includes donation of materials to charitable organizations; salvage of existing materials on-site; reclamation of products by manufacturers; and return of packaging materials to the manufacturer, shipper, or other source for reuse as packaging in future shipments.

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 yd^3 or 12,000 lbs per 10,000 ft^2 (35 m^3 or 6000 kg per 1000 m^2) 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 in accordance with the construction waste management plan required in Section 9.3.1.3.

9.3.1.3 Construction Waste Management Plan. Prior to issuance of a demolition or building permit, a preconstruction waste management plan shall be submitted to the *owner*. The plan shall

a. identify the construction and demolition waste materials expected to be diverted,
b. determine whether construction and demolition waste materials are to be source-separated or comingled,
c. identify service providers and designate destination facilities for construction and demolition waste materials generated at the job site, and
d. identify the average diversion rate for facilities that accept or process comingled construction and demolition materials. Separate average percentages shall be included for those materials collected by construction and demolition materials processing facilities that end up as *alternative daily cover* and incineration.

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).

9.3.3 Refrigerants. Chlorofluorocarbon (CFC) based refrigerants in HVAC&R systems shall not be used. Fire suppression systems shall not contain ozone-depleting substances (CFCs, hydrochlorofluorocarbons [HCFCs], or Halons).

9.3.4 Areas for Storage and Collection of Recyclables and Discarded Goods. Areas for recyclables and discarded goods shall be provided as described in this section. These areas shall be coordinated with the anticipated collection services to maximize the effectiveness of the dedicated areas. Instructions regarding the identification and handling of recyclables and discarded goods in these areas shall be posted in or adjacent to each dedicated area.

9.3.4.1 Recyclables. There shall be area(s) that serve the entire building and are dedicated to the collection and storage of nonhazardous materials for recycling, including paper, corrugated cardboard, glass, plastics, and metals.

9.3.4.2 Reusable goods. For *building projects* with *residential spaces*, there shall be an area that serves the entire building and is designed for the collection and storage of discarded but clean items in good condition. Charitable organizations or others to arrange for periodic pickups shall be identified and posted.

9.3.4.3 Fluorescent and High-Intensity Discharge (HID) Lamps and Ballasts. An area shall be provided that serves the entire building and is designed for the collection and storage of fluorescent and HID lamps and ballasts and facilitates proper disposal and/or recycling according to jurisdictional hazardous waste requirements.

9.3.4.4 *Electronics* and Batteries. Separate containers or areas shall be provided that serve the entire building and are designed for the collection and storage of *electronics*, alkaline batteries, and rechargeable batteries and facilitate disposal or recycling according to jurisdictional requirements.

9.3.5 Mercury Content Levels of Lamps. Electric lamps used in the *building project* shall not contain mercury in an amount exceeding, per lamp, the maximum mercury content levels of Table 9.3.5.

Exceptions:

1. Eight-foot models of straight fluorescent T8 lamps.
2. High-output and very-high-output, straight fluorescent lamps greater than 1.25 in. (32 mm) in diameter.
3. Mogul bi-pin-based lamps.
4. Preheat straight fluorescent lamps of any size.
5. U-bend and circline fluorescent lamps.
6. HID lamps.
7. Induction lamps.

TABLE 9.3.5 Maximum Mercury Content for Electric Lamps

Lamp	Maximum Mercury Content
Screw-base compact fluorescent lamps <25 W	4 mg
Screw-base compact fluorescent lamps ≥25 W and <40 W	5 mg
Pin-base compact fluorescent lamps, all wattages	5 mg
Straight fluorescent T5 normal lifetime lamps[a]	3 mg
Straight fluorescent T8 normal lifetime lamps[a]	4 mg
Straight fluorescent T5 and T8 long lifetime lamps[b]	5 mg
T12 eight-foot straight fluorescent lamps	15 mg

a. Electric lamps with a rated lifetime less than 25,000 h when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned off and on every three hours.

b. Electric lamps with a rated lifetime equal to or greater than 25,000 hours when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned off and on every three hours.

8. Special-purpose lamps: appliance, black light, germicidal, bug, colored, plant, straight fluorescent reflector, reprographic, shatter resistant, cold temperature, and three-way lamps.

9.4 Prescriptive Option

9.4.1 Reduced Impact Materials. The *building project* shall comply with any two of the following: Sections 9.4.1.1, 9.4.1.2, 9.4.1.3, or 9.4.1.4. Calculations shall only include materials *permanently installed* in the project. A value of 45% of the total construction cost shall be permitted to be used in lieu of the actual total cost of materials.

9.4.1.1 *Recycled Content* and *Salvaged Material* Content. The sum of the *recycled content* and the *salvaged material* content shall constitute a minimum of 10%, based on cost, of the total materials in the *building project.*

9.4.1.1.1 *Recycled Content.* The *recycled content* of a material shall be the *postconsumer recycled content* plus one-half of the *preconsumer recycled content*, determined by weight (mass). The recycled fraction of the material in a product or an assembly shall then be multiplied by the cost of the product or assembly to determine its contribution to the 10% requirement.

The annual average industry values, by country of production, for the *recycled content* of steel products manufactured in basic oxygen furnaces and electric arc furnaces shall be permitted to be used as the *recycled content* of the steel. For the purpose of calculating the *recycled content* contribution of concrete, the constituent materials in concrete (e.g., the cementitious materials, aggregates, and water) shall be permitted to be treated as separate components and calculated separately.

9.4.1.1.2 *Salvaged Material* Content. The *salvaged material* content shall be determined based on the actual cost of the *salvaged material* or the cost of a comparable alternative component material.

9.4.1.2 Regional Materials. A minimum of 15% of building materials or products used, based on cost, shall be regionally extracted/harvested/recovered or manufactured within a radius of 500 mi (800 km) of the project *site.* If only a fraction of a product or material is extracted/harvested/recovered or manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

Exception: For building materials or products shipped in part by rail or water, the total distance to the project shall be determined by weighted average, whereby that portion of the distance shipped by rail or water shall be multiplied by 0.25 and added to that portion not shipped by rail or water, provided that the total does not exceed 500 mi (800 km).

9.4.1.3 Biobased Products. A minimum of 5% of building materials used, based on cost, shall be *biobased product*s. *Biobased products* shall

a. comply with the minimum biobased contents of the USDA's BioPreferred Program;
b. contain the "USDA Certified *Biobased Product*" label; or
c. be composed of solid wood, engineered wood, bamboo, wool, cotton, cork, agricultural fibers, or other biobased materials with at least 50% biobased content.

9.4.1.3.1 Wood Building Components. Wood building components, including but not limited to structural framing, sheathing, flooring, subflooring, wood window sash and frames, doors, and architectural millwork, used to comply with this requirement shall contain not less than 60% certified wood content tracked through a chain of custody process, either by physical separation or percentage-based approaches, or wood that qualifies as a *salvaged material*. Certified wood content documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59, or the WTO Technical Barriers to Trade. Wood building components from a *vendor* shall be permitted to comply when the annual average amount of certified wood products purchased by the *vendor*, for which they have chain of custody *verification* not older than two years, is 60% or greater of their total annual wood products purchased.

9.4.1.4 Multiple-Attribute Product Declaration or Certification. A minimum of ten different products installed in the *building project* at the time of issuance of certificate of occupancy shall comply with one of the following subsec-

tions. Declarations, reports, and assessments shall be submitted to the *authority having jurisdiction* (*AHJ*) and shall contain documentation of the critical peer review by an independent third party, results from the review, the reviewer's name, company name, contact information, and date of the review or certification.

9.4.1.4.1 Industry-Wide Declaration. A Type III industry-wide environmental product declaration (EPD) shall be submitted for each product. Where the program operator explicitly recognizes the EPD as fully representative of the product group on a national level, it is considered industry-wide. In the case where an industry-wide EPD represents only a subset of an industry group, as opposed to being industry-wide, the manufacturer shall be explicitly recognized as a participant by the EPD program operator. All EPD shall be consistent with ISO Standards 14025 and 21930, with at least a cradle-to-gate scope. Each product complying with this section shall be counted as one product for compliance with Section 9.4.1.4.

9.4.1.4.2 Product-Specific Declaration. A product-specific Type III EPD shall be submitted for each product. The product-specific declaration shall be manufacturer-specific for a product family. Type III EPDs shall be certified as complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930. Each product complying with this section shall be counted as two products for compliance with Section 9.4.1.4.

9.4.1.4.3 Third-Party Multiattribute Certification. A material specific assessment shall be submitted for each product in accordance with one of the following standards, where applicable. The assessment shall be certified as meeting the minimum performance level specified in each standard. Each product complying with this section shall be counted as two products for compliance with Section 9.4.1.4.

a. ANSI/BIFMA e3
b. NSF/ANSI 140
c. NSF/ANSI 332
d. NSF/ANSI 336
e. NSF/ANSI 342
f. NSF/ANSI 347
g. NSC 373
h. ANSI A138.1
i. UL 100
j. UL 102

9.4.1.4.4 Product Life Cycle. A report by a third-party that has critically reviewed the *life-cycle assessment* (*LCA*) of a product based on ISO Standards 14040 and 14044 that demonstrates compliance with the goal and scope for the cradle-to-gate requirements. Each product complying with this section shall be counted as two products for compliance with Section 9.4.1.4.

9.5 Performance Option

9.5.1 *Life-Cycle Assessment* (*LCA*). An *LCA* shall be performed in accordance with ISO Standard 14044 for a minimum of two building alternatives, considering at least those material components included for consideration in Section 9.4.1, both of which shall conform to the *owner's project requirements* (*OPR*). Each building alternative shall consist of a common design, construction, and materials for the locale, including building size and use, as commonly approved by the *AHJ*. Each building alternative shall comply with Sections 6, 7, and 8. The service life of the buildings shall be not less than that determined using Table 10.3.2.3, except that the design life of long-life buildings shall be no less than 75 years.

9.5.1.1 *LCA* Performance Metric. The building alternative chosen for the project shall have a 5% improvement over the other building alternative assessed in the *LCA* in a minimum of two of the impact categories. The impact categories are land use (or habitat alteration), resource use, climate change, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, and eutrophication.

9.5.1.2 Procedure. The *LCA* shall include the following three steps:

Step 1: Perform a life-cycle inventory (LCI). The LCI accounts for all the individual environmental flows to and from the material components in a building throughout its life cycle.

a. The LCI shall include the materials and energy consumed and the emissions to air, land, and water for each of the following stages:
   1. Extracting and harvesting materials and fuel sources from nature.
   2. Processing building materials and manufacturing building components.
   3. Transporting materials and components.
   4. Assembly and construction.
   5. Maintenance, repair, and replacement during the design life with or without operational energy consumption.
   6. Demolition, disposal, recycling, and reuse of the building at the end of its life cycle.
b. The LCI shall account for emissions to air for the following:
   1. The six principal pollutants for which the USEPA has set National Ambient Air Quality Standards as required by the Clean Air Act and its amendments: carbon monoxide, nitrogen dioxide, lead, sulfur oxides, particulate matter (PM10 and PM2.5), and ozone.
   2. Greenhouse gases (not including water vapor and ozone) as described in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, hydrochlorofluorocarbons, bromofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, sulfur dioxide, and volatile organic compounds.
   3. Hazardous air pollutants listed in the Clean Air Act and its amendments.

Step 2: Compare the two building alternatives using a published third-party impact indicator method that includes, at a minimum the impact categories listed in Section 9.5.1.1. An *LCA* report shall be prepared that meets the requirements for third-party reporting in ISO Standard 14044 and also includes the following:

a. A description of the two building alternatives, including
   1. a description of the system boundary used,
   2. the design life of each building, and
   3. the physical differences between buildings.
b. The impact indicator method and impact categories used.
c. The results of the *LCA* indicating a minimum of 5% improvement in the proposed building compared to the other building alternative for a minimum of two impact categories, including an explanation of the rationale for the weighting and averaging of the impacts.

Step 3: Conduct a critical review by an external expert independent of those performing the *LCA*.

9.5.1.3 Reporting. The following shall be submitted to the *AHJ*:

a. The *LCA* report.

b. The documentation of critical peer review by a third party including the results from the review and the reviewer's name and contact information.

10. CONSTRUCTION AND PLANS FOR OPERATION

10.1 Scope. This section specifies requirements for construction and plans for operation, including the *commissioning (Cx) process*, building acceptance testing, measurement and *verification*, energy use reporting, durability, transportation management, erosion and sediment control, construction, and indoor air quality during construction.

10.2 Compliance. All of the provisions of Section 10 are mandatory provisions.

10.3 Mandatory Provisions

10.3.1 Construction

10.3.1.1 Building Acceptance Testing. Acceptance testing shall be performed on all buildings in accordance with this section using *generally accepted engineering standards* and handbooks acceptable to the *authority having jurisdiction* (*AHJ*).

An acceptance testing process shall be incorporated into the design and construction of the *building project* that verifies systems specified in this section perform in accordance with *construction documents*.

10.3.1.1.1 Activities Prior to Building Permit. Complete the following:

a. Designate a project *acceptance representative* to lead, review, and oversee completion of acceptance testing activities.
b. *Construction documents* shall indicate who is to perform acceptance tests and the details of the tests to be performed.
c. *Acceptance representative* shall review *construction documents* to verify that relevant sensor locations, devices, and control sequences are properly documented.

10.3.1.1.2 Activities Prior to Building Occupancy. Complete the following:

a. Verify proper installation and start up of the systems.
b. Perform acceptance tests. For each acceptance test, complete test form and include a signature and license number, as appropriate, for the party who has performed the test.
c. Verify that a systems manual has been prepared that includes operation and maintenance (O&M) documentation and full warranty information and provides operating staff the information needed to understand and optimally operate building systems.

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, indoor air quality (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*.
d. Renewable energy systems.
e. Water measurement devices, as required in Section 6.3.3.
f. Energy measurement devices, as required in Section 7.3.3.

10.3.1.1.4 Documentation. The *owner* shall retain completed acceptance test forms.

10.3.1.2 *Building Project* Commissioning. For buildings that exceed 5000 ft^2 (500 m^2) of gross floor area, commissioning shall be performed in accordance with this section using *generally accepted engineering standards* and handbooks acceptable to the *AHJ*. Buildings undergoing the *Cx process* will be deemed to comply with the requirements of Section 10.3.1.1, "Building Acceptance Testing."

A *Cx process* shall be incorporated into the predesign, design, construction, and first year occupancy of the *building project* that verifies that the delivered building and its components, assemblies, and systems comply with the documented *owner's project requirements* (*OPR*). Procedures, documentation, tools, and training shall be provided to the building operating staff to sustain features of the building assemblies and systems for the service life of the building. This material shall be assembled and organized into a systems manual that provides necessary information to the building operating staff to operate and maintain all commissioned systems identified within the *building project*.

10.3.1.2.1 Activities Prior to Building Permit. The following activities shall be completed:

a. Designate a project *commissioning authority* (*CxA*) to lead, review, and oversee completion of the *Cx process* activities prior to completion of schematic design.
b. The *owner*, in conjunction with the design team as necessary, shall develop the *OPR* during the predesign phase. The *OPR* shall be updated during the design phase as necessary by the design team, in conjunction with the *owner* and the Cx team. The *OPR* will be distributed to all parties participating in project programming, design, construction, and operations, and to the Cx team members.
c. The design team shall develop the *Basis of Design (BoD)*. The *BoD* document shall include all the information required in Section 6.2, "Documentation," of ANSI/ASHRAE Standard 55.
d. The *CxA* shall review both the *OPR* and *BoD* to ensure that no conflicting requirements or goals exist and that the *OPR* and *BoD*, based on the professional judgment and experience of the *CxA*, are sufficiently detailed for the project being undertaken.
e. Construction phase commissioning requirements shall be incorporated into project specifications and other *construction documents* developed by the design team.
f. The *CxA* shall conduct two focused *OPR* reviews of the *construction documents*, the first at near 50% design completion and the second of the final *construction documents* prior to delivery to the contractor. The purpose of these reviews is to verify that the documents achieve the construction phase *OPR* and that the *BoD* document fully supports the *OPR* with sufficient details.
g. Develop and implement a *commissioning* (*Cx*) *plan* containing all required forms and procedures for the complete

testing of all equipment, systems, and controls included in Section 10.3.1.2.4.

10.3.1.2.2 Activities Prior to Building Occupancy. The following activities shall be completed:

a. Verify the installation and performance of the systems to be commissioned, including completion of the *construction checklist* and *verification*.

Exception to 10.3.1.2.2(a): Systems that, because their operation is seasonally dependent, cannot be fully commissioned in accordance with the *Cx plan* at time of occupancy. These systems shall be commissioned at the earliest time after occupancy when operation of systems is allowed to be fully demonstrated as determined by *CxA*.

b. It shall be verified that the *owner* requirements for the training of operating personnel and building occupants is completed. Where systems cannot be fully commissioned at the time of occupancy because of seasonal dependence, the training of personnel and building occupants shall be completed when the systems' operation can be fully demonstrated by the *CxA*.
c. Complete preliminary Cx report.
d. Verify that a systems manual has been prepared that includes O&M documentation and full warranty information and provides operating staff the information needed to understand and operate the commissioned systems as designed.

10.3.1.2.3 Postoccupancy Activities. Complete the following:

a. Complete any commissioning activities called out in the *Cx plan* for systems whose commissioning can only be completed subsequent to building occupancy, including trend logging and off-season testing.
b. Verify that the *owner* requirements for training operating personnel and building occupants are completed for those systems whose seasonal operational dependence mean they were unable to be fully commissioned prior to building occupancy.
c. Complete a final Cx report.

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

a. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive).
b. *Building envelope* systems, components, and assemblies to verify the airtightness and thermal and moisture integrity. *Building envelope* airtightness commissioning shall also comply with Section 10.3.1.2.5.
c. Lighting systems.
d. *Fenestration* control systems: *Automatic* controls for shading devices and *dynamic glazing*.
e. Irrigation.
f. Plumbing.
g. Domestic and process water pumping and mixing systems.
h. *Service water heating* systems.
i. Renewable energy systems.
j. Water measurement devices, as required in Section 6.3.3.
k. Energy measurement devices, as required in Section 7.3.3.

10.3.1.2.5 *Building Envelope* Airtightness. *Building envelope* airtightness shall comply with one of the following:

a. Whole building pressurization testing shall be conducted in accordance with ASTM E779, CAN/CGSB-149.10-M86, CAN/CGSB-149.15-96 or equivalent. The measured air leakage rate of the *building envelope* shall not exceed 0.25 cfm/ft^2 (1.25 L/s·m^2) under a pressure differential of 0.3 in. wc (75 Pa), with this air leakage rate normalized by the sum of the above- and below-grade *building envelope* areas of the *conditioned* and *semiheated space.*
b. An air-barrier commissioning program consistent with *generally accepted engineering standards* that consists of the following elements shall be implemented:
    1. A third-party design review shall be conducted and documented to assess the design documentation describing the air-barrier systems and materials, the manner in which continuity will be maintained across joints between air-barrier components and at all envelope penetrations, and the constructability of the air-barrier systems.
    2. Incremental field inspection and testing of air-barrier components shall be conducted and documented during construction to ensure proper construction of key components while they are still accessible for inspection and repair.

10.3.1.2.6 Documentation. *Owner* shall retain the systems manual and final Cx report.

10.3.1.3 Erosion and Sedimentation Control (ESC). Develop and implement an ESC plan for all construction activities. The ESC plan shall conform to the erosion and sedimentation control requirements of the most current version of the USEPA NPDES General Permit for Stormwater Discharges From Construction Activities or local erosion and sedimentation control standards and codes, whichever is more stringent, and regardless of size of project.

10.3.1.4 Indoor Air Quality (IAQ) Construction Management. Develop and implement an IAQ construction management plan to include the following:

a. Air conveyance materials shall be stored and covered so that they remain clean. All filters and controls shall be in place and operational when HVAC systems are operated during building flush-out or baseline IAQ monitoring. Except for system startup, testing, balancing, and commissioning, permanent HVAC systems shall not be used during construction.
b. After construction ends, prior to occupancy and with all interior finishes installed, a postconstruction, preoccupancy building flush-out as described under Section 10.3.1.4(b)(1), or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 10.3.1.4(b)(2) shall be performed:

1. **Postconstruction, preoccupancy flush-out.** A total air volume of *outdoor air* in total air changes as defined by Equation 10-1 shall be supplied while maintaining an internal temperature of a minimum of 60°F (15°C) and relative humidity no higher than 60%. For buildings located in nonattainment areas, filtration and/or air cleaning as described in Section 8.3.1.3 shall be supplied when the Air Quality Index forecast exceeds 100 (category orange, red, purple, or maroon). One of the following options shall be followed:
   i. **Continuous postconstruction, preoccupancy flush-out.** The flush-out shall be continuous and supplied at an *outdoor airflow* rate no less than that determined in Section 8.3.1.1.
   ii. **Continuous postconstruction, preoccupancy/ postoccupancy flush-out.** If occupancy is desired prior to completion of the flush-out, the *space* is allowed to be occupied following delivery of half of the total air changes calculated from Equation 10-1 to the *space*. The *space* shall be ventilated at a minimum rate of 0.30 cfm per ft^2 (1.5 L/s per m^2) of *outdoor air* or the *outdoor airflow* rate determined in Section 8.3.1.1, whichever is greater. These conditions shall be maintained until the total air changes calculated according to Equation 10-1 have been delivered to the *space*. The flush out shall be continuous.

$$\text{TAC} = V_{ot} \times \frac{1}{A} \times \frac{1}{H} \times H \times 60 \text{ min/h} \times 24 \text{ h/day} \times 14 \text{ days} \quad \text{(I-P)} \tag{10-1}$$

$$\text{TAC} = V_{ot} \times \frac{1 \text{ m}^3}{1000L} \times \frac{1}{A} \times \frac{1}{H} \times 3600 \text{ s/h} \times 24 \text{ h/day} \times 14 \text{ days} \quad \text{(SI)}$$

where

TAC = total air changes

V_{ot} = system design *outdoor air* intake flow, cfm (L/s) (according to Equation 6-8 of ANSI/ ASHRAE Standard 62.1)

A = floor area, ft^2 (m^2)

H = ceiling height, ft (m)

2. **Postconstruction, preoccupancy baseline IAQ monitoring.** Baseline IAQ testing shall be conducted after construction ends and prior to occupancy. The ventilation system shall be operated continuously within ±10% of the *outdoor airflow* rate provided by the ventilation system at design occupancy for a minimum of 24 hours prior to IAQ monitoring. Testing shall be done using protocols consistent with the USEPA Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, TO-1, TO-11, TO-17 and ASTM Standard Method D 5197. The testing shall demonstrate that the *contaminant* maximum con-

TABLE 10.3.1.4 Maximum Concentration of Air Pollutants Relevant to IAQ

Contaminant	Maximum Concentration, µg/m^3 (Unless Otherwise Noted)
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-h)
Particulates (PM2.5)	35 (24-h)
Particulates (PM10)	150 (24-h)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-Butadiene	20
t-Butyl methyl ether (Methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam [a]	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1,4-Dichlorobenzene	800
Dichloromethane (Methylene chloride)	400
1,4-Dioxane	3000
Ethylbenzene	2000
Ethylene glycol	400
Formaldehyde	33
2-Ethylhexanoic acid*	25
n-Hexane	7000
1-Methyl-2-pyrrolidinone*	160
Naphthalene	9
Nonanal*	13
Octanal*	7.2
Phenol	200
4-Phenylcyclohexene (4-PCH)*	2.5
2-Propanol (Isopropanol)	7000
Styrene	900
Tetrachloroethene (Tetrachloroethylene, Perchloroethylene)	35
Toluene	300
1,1,1-Trichloroethane (Methyl chloroform)	1000
Trichloroethene (Trichloroethylene)	600
Xylene isomers	700
Total volatile organic compounds (TVOC)	—[b]

a. This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.

b. TVOC reporting shall be in accordance with CDPH/EHLB/Standard Method V1.1 and shall be in conjunction with the individual VOCs listed above.

centrations listed in Table 10.3.1.4 are not exceeded in the return airstreams of the HVAC systems that serve the *space* intended to be occupied. If the return airstream of the HVAC system serving the *space* intended to be occupied cannot be separated from other *spaces* either already occupied or not occupied at all, for each portion of the building served by a separate ventilation system, the testing shall demonstrate that the *contaminant* maximum concentrations at *breathing zone* listed in Table 10.3.1.4 are not exceeded in the larger of the following number of locations: (a) no fewer than one location per 25,000 ft^2 (2500 m^2) or (b) in each contiguous floor area. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with *outdoor air*, and retest the specific parameter(s) exceeded to demonstrate that the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from the same locations as in the first test.

10.3.1.5 Moisture Control. The following items to control moisture shall be implemented during construction:

a. Materials stored on-site or materials installed that are absorptive shall be protected from moisture damage.
b. Building construction materials that show visual evidence of biological growth due to the presence of moisture shall not be installed on the *building project*.

10.3.1.6 Construction Activity Pollution Prevention: Idling of Construction Vehicles. Construction-related vehicles shall not idle on the construction *site* for more than five minutes in any 60-minute period, except where necessary to perform their construction-related function. Signage shall be posted at vehicle entrances to the *building project* providing notice of this requirement.

10.3.1.7 Construction Activity Pollution Prevention: Protection of Occupied Areas. The *construction documents* shall identify operable windows, doors, and air intake openings that serve occupied *spaces*, including those not associated with the *building project*, that are in the area of construction activity or within 35 ft (11 m) of the limits of construction activity. Such windows, doors, and air intake openings that are under control of the *owner* shall be closed, or other measures shall be taken to limit *contaminant* entry.

Management of the affected building(s) not under the control of the *building project owner* shall be notified in writing of planned construction activity and possible entry of *contaminants* into their building(s).

10.3.1.8 Construction Waste Management

10.3.1.8.1 Collection. Specific area(s) on the construction *site* shall be designated for collection of recyclable and reusable materials. Alternatively, off-site storage and sorting of materials shall be permitted. Diversion efforts shall be tracked throughout the construction process.

10.3.1.8.2 Documentation. Prior to issuance of the final certificate of occupancy, a final construction waste management report documenting compliance with Section 9.3.1 shall be submitted to the *owner* and *AHJ*.

10.3.2 Plans for Operation. This section specifies the items to be included in plans for operation of a *building project* that falls under the requirements of this standard.

10.3.2.1 High-Performance Building Operation Plan. A master building plan for operation shall be developed that meets the requirements specified in Sections 10.3.2.1.1 through 10.3.2.1.4.

10.3.2.1.1 *Site* Sustainability. A *site* sustainability portion of the plan for operation shall be developed and shall contain the following provisions:

a. When trees and vegetation are used to comply with the shade requirements of Section 5.3.4, the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Section 5.
b. For *roof* materials selected to comply with the requirements of Section 5.3.4.3, the plan for operation shall include the maintenance procedures for keeping the *roof* surfaces cleaned in accordance with manufacturer's recommendations.

10.3.2.1.2 Water Use Efficiency. The plan for operation shall specify water use *verification* activities for *building projects* to track and assess building water consumption. The plan shall describe the procedures needed to comply with the requirements outlined below.

10.3.2.1.2.1 Initial Measurement and *Verification*. Use the water measurement devices and collection/storage infrastructure specified in Section 6.3.3 to collect and store water use data for each device, starting no later than after building acceptance testing has been completed and certificate of occupancy has been issued.

10.3.2.1.2.2 Track and Assess Water Use. The plan shall specify the procedures for tracking and assessing the *building project* water use and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Usage reports.** Develop a plan for collecting *building project* water use data for water sources and subsystems measured in Section 6.3.3.
b. **Benchmark water performance.** Develop a plan to enter building operating characteristics and water use data into the ENERGY STAR® Portfolio Manager. For building parameter inputs into Portfolio Manager (e.g., number of occupants, hours of operation, etc.), use actual average values.
c. **Assess water use performance.** Develop a plan to assess *building project* water use efficiency.

10.3.2.1.2.3 Documentation of Water Use. All documents associated with the measurement and *verification* of

the building's water use shall be retained by the *owner* for a minimum of three years.

10.3.2.1.3 Energy Efficiency. The plan for operation shall specify energy performance *verification* activities for *building projects* to track and assess building energy performance. The plan shall describe the procedures needed to comply with the requirements outlined in the following subsections.

10.3.2.1.3.1 Initial Measurement and *Verification*. Use the energy measurement devices and collection/storage infrastructure specified in Section 7.3.3 to collect and store energy data for each device, starting no later than after acceptance testing has been completed and certificate of occupancy has been issued.

10.3.2.1.3.2 Track and Assess Energy Consumption. The plan for operation shall specify the procedures for tracking and assessing the *building project* energy performance, and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

a. **Energy usage reports.** Develop a plan for collecting *building project* energy data for energy sources and system energy loads measured in Section 7.3.3. The reports shall include the following, as a minimum:
   1. Hourly load profile for each day.
   2. Monthly average daily load profile.
   3. Monthly and annual energy use.
   4. Monthly and annual peak demand.
b. **Track energy performance.** Develop a plan to enter building operating characteristics and energy consumption data into the ENERGY STAR Portfolio Manager for those building types addressed by this program to track building performance. For building parameter inputs into Portfolio Manager (e.g., number of occupants, hours of operation, number of PCs, etc.), use actual average values.
c. **Assess energy performance.** Develop a plan to assess *building project* energy performance.

10.3.2.1.3.3 Documentation of Energy Efficiency. All documents associated with the measurement and *verification* of the building's energy efficiency shall be retained by *owner*.

10.3.2.1.4 Indoor Environmental Quality. The plan for operation shall include the requirements of Section 8 of ANSI/ASHRAE Standard 62.1 and shall describe additional procedures, as outlined in Sections 10.3.2.1.4.1 through 10.3.2.1.4.6, for implementing a regular indoor environmental quality measurement and *verification* program after building occupancy.

10.3.2.1.4.1 *Outdoor Airflow* Measurement. The plan for operation shall document procedures for implementing a regular *outdoor airflow* monitoring program after building occupancy and shall meet the following requirements:

a. For each mechanical ventilation system where direct *outdoor airflow* measurement is required according to Section 8.3.1.2, a procedure shall be in place to respond when there is notification that the *minimum outdoor airflow* is in an *outdoor air fault condition*. For systems that use a damper indicator instead of a direct measurement, per the exception to Section 8.3.1.2, a procedure shall be in place to respond when there is notification that the indicator identifies that the damper is out of position.
b. For each mechanical ventilation system where direct *minimum outdoor airflow* measurement is required according to Section 8.3.1.2, the *minimum outdoor airflow* shall be recorded every three months in either electronic or written form.
c. For systems that use a damper indicator, per the exception to Section 8.3.1.2, the *minimum outdoor airflow* shall be measured and recorded in either electronic or written form every two years for air-handling systems with a design supply airflow rate of more than 2000 cfm (1000 L/s). The *minimum outdoor airflow* shall be measured using methods as described in ANSI/ASHRAE Standard 111 and with an accuracy of ±10% or better.

10.3.2.1.4.2 *Outdoor Airflow* Scheduling. Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.

10.3.2.1.4.3 *Outdoor Airflow* Documentation. The following documentation shall be maintained concerning *outdoor airflow* measurement and *verification*:

a. A list of each air system requiring direct *outdoor air* flow measurement.
b. Monitoring procedures and monitoring frequencies for each monitored sensing device, including a description of the specific response measures to be taken if needed.
c. Ventilation systems shall be operated such that *spaces* are ventilated when these *spaces* are expected to be occupied.
d. Operation and calibration check procedures and the records associated with operation checks and recalibration.

10.3.2.1.4.4 Indoor Air Quality. The plan for operation shall document procedures for maintaining and monitoring indoor air quality after building occupancy and shall contain the following:

a. For buildings located in nonattainments areas for PM2.5 as defined by the USEPA, air filtration and/or air cleaning equipment as defined in Section 8.3.1.3(a) shall be operated continuously during occupied hours or when the USEPA Air Quality Index exceeds 100 or equivalent designations by the local authorities for PM2.5.

Exception to 10.3.2.1.4.4(a): *Spaces* without mechanical ventilation.

b. For buildings located in nonattainments areas for ozone as defined by the USEPA, air-cleaning equipment as defined in Section 8.3.1.3(b) shall be operated continuously during occupied hours during the local summer and fall seasons, or when the USEPA Air Quality Index exceeds 100 or equivalent designations by the local authorities for ozone.

TABLE 10.3.2.3 Minimum Design Service Life for Buildings

Category	Minimum Service Life	Building Types
Temporary	Up to 10 years	Nonpermanent construction buildings (sales offices, bunkhouses) Temporary exhibition buildings
Medium life	25 years	Industrial buildings Stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

Exception to 10.3.2.1.4.4(b): *Spaces* without mechanical ventilation.

c. Biennial monitoring of Indoor Air Quality by one of the following methods:

1. Performing IAQ testing as described in Section 10.3.1.4.
2. Monitoring occupant perceptions of indoor air quality by any method, including but not limited to occupant questionnaires.
3. Each building shall have an occupant complaint/ response program for IEQ.

10.3.2.1.4.5 Building Green Cleaning Plan. A green cleaning plan shall be developed for the *building project* in compliance with Green Seal Standard, GS-42.

Exception: *Dwelling units* of a *building project.*

10.3.2.1.4.6 Document all measurement and *verification* data.

10.3.2.2 *Maintenance Plan*. A *maintenance plan* shall be developed for mechanical, electrical, plumbing, and fire protection systems. The plan shall include the following:

a. The plan shall be in accordance with ANSI/ASHRAE/ ACCA Standard 180 for HVAC systems in buildings that meet the definition of commercial buildings in ANSI/ ASHRAE/ACCA Standard 180.
b. The plan shall address all elements of Section 4 of ANSI/ ASHRAE/ACCA Standard 180 and shall develop required inspection and maintenance tasks similar to Section 5 of ANSI/ASHRAE/ACCA Standard 180 for electrical and plumbing systems in buildings that meet the definition of commercial buildings in ANSI/ASHRAE/ACCA Standard 180.
c. *Outdoor air* delivery monitors required by Section 8.3.1.2 shall be visually inspected at least once each quarter and cleaned or repaired as necessary and calibrated at the manufacturer's recommended interval or not less than once per year, whichever is more frequent.
d. For systems with a damper indicator and with less than 2000 cfm (1000 L/s) of supply air, the system components that control the *minimum outdoor airflow* shall be visually inspected every two years. Records of this inspection shall be maintained on-site either in electronic or written form.
e. Documentation of the plan and of completed maintenance procedures shall be maintained on the building *site* at all times in

1. electronic format for storage on the building energy management system (EMS), building management system (BMS), computerized maintenance management system (CMMS), or other computer storage means, or
2. maintenance manuals specifically developed and maintained for documenting completed maintenance activities.

10.3.2.3 Service Life Plan. A service life plan that is consistent with the *OPR* shall be developed to estimate to what extent structural, *building envelope* (not mechanical and electrical), and *hardscape* materials will need to be repaired or replaced during the service life of the building. The design service life of the building shall be no less than that determined using Table 10.3.2.3. The estimated service life shall be documented for building assemblies, products, and materials that will need to be inspected, repaired, and/or replaced during the service life of the building. *Site* improvements and *hardscape* shall also be included. Documentation in the service life plan shall include the *building project* design service life and basis for determination, and the following for each assembly or component:

a. Building assembly description.
b. Materials or products.
c. Design or estimated service life, years.
d. Maintenance frequency.
e. Maintenance access for components with an estimated service life less than the service life of the building.

Provide a service life plan at the completion of design development. The *owner* shall retain a copy of the service life plan for use during the life of building.

10.3.2.4 Transportation Management Plan. A transportation management plan shall be developed compliant with the following requirements. *Owner* shall retain a copy of the transportation management plan.

10.3.2.4.1 All *Building Projects*. The plan shall include the following:

a. Preferred parking for carpools and vanpools with parking facilities.
b. A plan for bicycle transportation.

10.3.2.4.2 *Owner*-Occupied *Building Projects* or Portions of *Building Projects*. For *owner*-occupied buildings, or for the employees in the *owner*-occupied portions of a building, the building *owner* shall offer at least one of the following primary benefits to the *owner*'s employees:

a. Incentivize employees to commute using mass transit, vanpool, carpool, or nonmotorized forms of transportation.
b. Initiate a telework or flexible work schedule program that reduces by at least 5% the number of commuting trips by the *owner*'s employees.
c. Initiate a ridesharing or carpool matching program, either in-house or through an outside organization.

Exception to 10.3.2.4.2: Multifamily *residential building project.*

In addition, the *owner* shall provide all of the following to the *owner*'s employees:

a. Access to an *emergency ride home* for employees, either provided in-house or by an outside organization.
b. A central point of contact in charge of commuter benefits.
c. Maintenance of commuter benefits in a centralized location.
d. Active promotion of commuter benefits to employees.

10.3.2.4.3 Building Tenant. The building *owner*

a. shall provide a copy of the plan to tenants within the building and
b. shall not include parking fees in lease rates, or shall identify the value of parking in the lease.

10.4 Prescriptive Option. There are no prescriptive options.

10.5 Performance Option. There are no performance options.

11. NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

Reference	Title	Section
Air-Conditioning, Heating, and Refrigeration Institute (AHRI) **2111 Wilson Blvd, Suite 500** **Arlington, VA 22201, United States** **1-703-524-8800; www.ahrinet.org**		
ANSI/AHRI 210/240-2008 (with Addenda 1 and 2)	Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment	Appendix C
ANSI/AHRI 310/380-2004	Standard for Packaged Terminal Air-Conditioners and Heat Pumps	Appendix C
ANSI/AHRI 340/360-2007 (with Addenda 1 and 2)	Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment	Appendix C
ANSI/AHRI 390-2003	Performance Rating of Single Packaged Terminal Air-Conditioners and Heat Pumps	Appendix C
AHRI 550/590-2011 (with Addenda 1, 2, and 3) AHRI 551/591-2011 (with Addenda 1, 2, and 3)	Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle	Appendix C
ANSI/AHRI 560-2000	Absorption Water Chilling an Water Heating Packages	Appendix C
AHRI 1200-2010	Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets	Appendix C
AHRI 1230-2010 (with Addendum 1)	Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment	Appendix C
American National Standards Institute (ANSI) **25 West 43rd Street** **New York, NY 20036, United States** **1-212-642-4900; www.ansi.org**		
ANSI Z21.10.3-2011	Gas Water Heater, Volume 3, Storage, with Input Ratings above 75,000 BTU/h, Circulating with Instantaneous Water Heaters	Appendix C
ANSI Z21.47-2012	Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Furnaces)	Appendix C
ANSI Z83.8-2013	Gas Unit Heaters and Duct Furnaces	Appendix C
American Society of Mechanical Engineers (ASME) **Three Park Avenue** **New York, NY 10016-5990, United States** **1-800-843-2763 and 1-973-882-1170; www.asme.org**		
ASME A112.18.1-2012/CSA B125.1-12	Plumbing Supply Fittings	6.3.2.1
ASME A112.19.2-2013/CSA B45.1-13	Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals	6.3.2.1
ASME A112.19.14-2006	Six-Liter Water Closets Equipped with a Dual Flushing Device	6.3.2.1
ASME A112.19.19-2006	Vitreous China Nonwater Urinals	6.3.2.1
ASHRAE **1791 Tullie Circle NE** **Atlanta, GA 30329, United States** **1-404-636-8400; www.ashrae.org**		
ANSI/ASHRAE Standard 55-2010	Thermal Comfort Conditions for Human Occupancy	8.3.2, 10.3.1.2.1
ANSI/ASHRAE Standard 62.1-2013	Ventilation for Acceptable Indoor Air Quality	3.2, 7.4.3.2, 8.3, 10.3.1.4, 10.3.2.1.4
ANSI/ASHRAE/IES Standard 90.1-2013	Energy Standard for Buildings Except Low-Rise Residential Buildings	3.1, 3.2, 5.3.3.1, 5.3.3.3, 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

Reference	Title	Section
ANSI/ASHRAE Standard 111-2008	Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems	8.3.1.2.2, 10.3.2.1.4
ANSI/ASHRAE Standard 154-2003	Ventilation for Commercial Cooking Operations	
ANSI/ASHRAE Standard 160-2009	Criteria for Moisture-Control Design Analysis in Buildings	8.3.6
ANSI/ASHRAE Standard 169-2006	Weather Data for Building Design Standards	Appendix A
ANSI/ASHRAE/ASHE Standard 170-2008	Ventilation of Health Care Facilities	8.3.1
ANSI/ASHRAE/ACCA Standard 180-2008	Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems	3.2, 10.3.2.2
Association of Home Appliance Manufacturers (AHAM) **1111 19th Street NW, Suite 402** **Washington, DC, 20036, United States** **1-202-872-5955; www.aham.org**		
ANSI/AHAM RAC-1-R2008	Room Air Conditioners	Appendix C
ASTM International **100 Barr Harbor Dr.** **West Conshohocken, PA 19428-2959, United States** **1-610-832-9585; www.astm.org**		
ASTM C518-10	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	Appendix C
ASTM C1371-04a	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers	5.3.2.4
ASTM C1549-09	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer	5.3.2.4
ASTM D1003-11e1	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics	8.4.1.1.3, 8.4.1.3
ASTM D5197-09e1	Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)	10.3.1.4
ASTM E90-09	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements	8.3.3.3
ASTM E408-71(2008)	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques	5.3.2.4
ASTM E413-10	Classification for Rating Sound Insulation	8.3.3.3
ASTM E779-10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	10.3.1.2.5
ASTM E1332-10a	Standard Classification for the Determination of Outdoor-Indoor Transmission Class	8.3.3.3
ASTM E1903-11	Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process	3.2
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ASTM E1980-11	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces	5.3.2.4
The Business and Institutional Furniture Manufacturer's Association (BIFMA) **678 Front Avenue NW, Suite 150** **Grand Rapids, MI 49504-5368, United States** **1-616-285-3963; www.bifma.org; email@bifma.org**		
ANSI/BIFMA M7.1-2011	Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components and Seating	8.4.2.5 and 8.5.2
ANSI/BIFMA X7.1-2011	Standard for Formaldehyde and TVOC Emissions of Low-Emitting Office Furniture Systems and Seating	8.4.2.5
ANSI/BIFMA e3-2012	Furniture Sustainability Standard	8.4.2.5, 9.4.1.4.3

Reference	Title	Section
California Air Resources Board (CARB) 1001 "I" Street P.O. Box 2815 Sacramento, CA 95812, United States 1-916-322-2990; www.arb.ca.gov/homepage.htm		
CARB SCM for Architectural Coatings-2007	California Air Resources Board (ARB) Suggested Control Measure for Architectural Coatings	8.4.2.2.2
No-Added Formaldehyde Based Resins	Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products. California Code of Regulations, Title 17, Sections 93120-93120.12	8.5.2
California Department of Public Health (CDPH) Indoor Air Quality Section 850 Marina Bay Parkway Richmond, CA 94804, United States 1-510-620-2802; www.cdph.ca.gov/programs/IAQ and www.cal-iaq.org		
CDPH/EHLB/Standard Method V1.1	Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers—Version 1.1	8.4.2.1.1, 8.4.2.2.1, 8.4.2.3, 8.4.2.4, 8.4.2.6, 8.5.2, Table 10.3.1.4, Appendix F
Canadian General Standards Board Place du Portage III, 6B1 11 Laurier Street Gatineau, Quebec K1A 1G6 Canada 819-956-0425 www.tpsgc-pwgsc.gc.ca/ongc-cgsb/index-eng.html		
CAN/CGSB 149.10-M86	Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method	10.3.1.2.5
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Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) International Environment House 11 Chemin des Anémones CH-1219 Châtelaine, Geneva, Switzerland +41-(0)22-917-81-39/40		
CITES- 1973, amended 1979 and 1983	Convention on International Trade in Endangered Species of Wild Fauna and Flora	9.3.2
Cooling Roof Rating Council (CRRC) 449 15th Street, Suite 200 Oakland, CA 94612 United States 1-866-465-2523; www.coolroofs.org		
ANSI/CRRC Standard-1-2012	ANSI/CRRC-1 Standard	5.3.2.4
Cooling Technology Institute (CTI) 2611 FM 1960West, Suite A-101 Houston, TX 77068-3730; P.O. Box 73383 Houston, TX 77273-3383		
CTI ATC-105 (00)	Acceptance Test Code for Water Cooling Towers	Appendix C
CTI ATC-105S (11)	Acceptance Test Code for Closed-Circuit Cooling Towers	Appendix C
CTI ATC-106 (11)	Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers	Appendix C
CTI STD-201RS (13)	Performance Rating of Evaporative Heat Rejection Equipment	Appendix C
CTI STD-201OM (13)	Operations Manual for Thermal Performance Certification of Evaporative Heat Rejection Equipment	Appendix C

Reference	Title	Section
Cooling Tower Technology Institute (CTI) P.O Box 73383 Houston, TX 77273, United States 1-281-583-4087; www.cti.org		
CTI ATC-105 (2/2000)	Acceptance Test Code	Appendix C
CTI STD 201 (1/2009)	Standard for the Certification of Water Cooling Tower Thermal Performance	Appendix C
Green-e c/o Center for Resource Solutions 1012 Torney Ave., Second Floor San Francisco, CA 94129, United States 1- 415-561-2100; www.green-e.org		
Version 1.6, Dec 5, 2008	Green-e Energy National Standard for Renewable Electricity Products	7.4.1.1(2)
Green Seal 1001 Connecticut Avenue, NW, Suite 827 Washington, DC 20036-5525, United States 1-202-872-6400; www.greenseal.org		
GS-11, July 12, 2013	Environmental Standard for Paints and Coatings	8.4.2.2.2
GS-36, July 12, 2013	Standard for Commercial Adhesives	8.4.2.1.2
GS-42, July 12, 2013	Environmental Standard for Cleaning Services	10.3.2.1.4.5
Illuminating Engineering Society of North America 120 Wall Street, Floor 17 New York, NY 10005-4001, United States 1-212-248-5017, www.ies.org		
TM-15-2011 including addendum "a"	Luminaire Classification System for Outdoor Luminaires	5.3.3.2
International Association of Plumbing and Mechanical Officials (IAPMO) 5001 East Philadelphia Street Ontario, CA 91761, United States 1-909-472-4100; www.iapmo.org		
Z124.9-2004	Plastic Urinal Fixtures	6.3.2.1
International Organization for Standardization (ISO) ISO Central Secretariat, 1 rue de Varembee, Case postale 56 CH-1211 Geneva 20, Switzerland +41-22-749-01-11; www.iso.org		
ISO-13256-1-1998	Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps	Appendix C
ISO 14025-2006	Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures	9.4.1.4
ISO 14040-2006	Environmental Management—Life Cycle Assessment—Principles and Framework	9.4.1.4
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ISO 21930-2007	Sustainability in Building Construction—Environmental Declaration of Building Products	9.4.1.4
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Irrigation Association (IA) 6540 Arlington Boulevard Falls Church, VA 22042-6638, United States 1-703-536-7080; www.irrigation.org		
Smart Water Application Technology (SWAT) Climatological Based Controllers 8th Draft Testing Protocol – November 2006	Smart Water Application Technology (SWAT), Turf and Landscape Irrigation Equipment Climatologically Based Controllers	6.3.1.3

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42 USC§ 6291	Title 42—THE PUBLIC HEALTH AND WELFARE CHAPTER 77—ENERGY CONSERVATION SUBCHAPTER III—IMPROVING ENERGY EFFICIENCY Part A—Energy Conservation Program for Consumer Products Other than Automobiles Sec. 6291—Definitions	Appendix C, Table C-17
National Electrical Manufacturers Association (NEMA) 1300 North 17th Street, Suite 1752 Rosslyn, VA 22209, United States 1-703-841-3200; www.nema.org		
ANSI/NEMA MG-1-2011	Motors and Generators	Appendix C
NEMA DC 3, Annex A-2010	Energy-Efficiency Requirements for Programmable Thermostats	7.4.7.4
National Fire Protection Association 1 Battery March Park Quincy, MA 02169-7471 United States 1-617-770-0700; www.nfpa.org		
NFPA 70 -2011	National Electrical Code	5.3.3
Natural Stone Council P.O. Box 539 Hollis, NH 03049, United States 978-391-4130; www.naturalstonecouncil.org; info@genuinestone.org		
NSC 373-2013	Sustainability Assessment for Natural Dimension Stone	9.4.1.4
NSF International 789 Dixboro Road Ann Arbor, MI 48105, United States 734-769-8010; www.nsf.org; info@nsf.org		
NSF/ANSI 140-2013	Sustainability Assessment for Carpet	9.4.1.4
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South Coast Air Quality Management District (SCAQMD) California Air Resources Board 1001 "I" Street P.O. Box 2815 Sacramento, CA 95812, United States 1-916-322-2990; www.arb.ca.gov		
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SCAQMD Rule 1168, Amended January 7, 2005	Adhesive and Sealant Applications	8.4.2.1
Tile Council of North America 100 Clemson Research Boulevard Anderson, SC 29625, United States 864-646-8453; www.tcnatile.com; info@tileusa.com		
ANSI A138.1-2012	Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials	9.4.1.4

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Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062, United States 847-272-8800; www.ul.com; cec.us@us.ul.com		
UL 100-2012	Standard for Sustainability for Gypsum Boards and Panels	UL 100-2012
UL 102-2012	Standard for Sustainability for Door Leafs	UL 102-2012
UL 727-2006	Standard for Oil-Fired Central Furnaces	Appendix C
UL 731-2012	Standard for Oil-Fired Unit Heaters	Appendix C
United States Congress Washington, DC 20515, United States 1-202-224-3121; http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf and www.govtrack.us/data/us/bills.text/110/h/h6.pdf		
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EISA 2007 HR6 Public Law 110-140	The Energy Independence and Security Act of 2007	7.4.3, 7.4.7
United States Department of Agriculture (USDA) BioPreferred Program 1400 Independence Avenue, SW Washington, DC 20250, United States 1-202-720-2791; www.biopreferred.gov		
7 CFR Part 3201 Subpart B, (Includes Rounds 1–7) August 29, 2011; Round 8, April 4, 2012; Round 9, November 19, 2012; Round 10, June 11, 2013	Guidelines for Designating Biobased Products for Federal Procurement; Designated Items	9.4.1.3
United States Department of Energy (U.S. DOE) Energy Information Administration Washington, DC 20585, United States 1-202-586-5000; www.eia.doe.gov/emeu/cbecs/contents.html and http://tonto.eia.doe.gov/state		
EIA Average Energy Prices	State and U.S. Historical Data	Appendix D
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United States Environmental Protection Agency (EPA) Ariel Rios Building 1200 Pennsylvania Avenue, NW Washington, DC 20460, United States 1-919-541-0800; www.epa.gov ENERGY STAR ® 1-888-782-7937 WaterSense 1-866-987-7367 and 1-202-564-2660		
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World Trade Organization (WTO) Centre William Rappard Rue de Lausanne 154, CH-1211 Geneva 21, Switzerland 41-22-739-51-11; www.wto.org		
WTO TBT-1994	WTO Technical Barriers to Trade (TBT) Agreement Annex 3 Code of Good Practice for the Preparation, Adoption and Application of Standards	9.4.1.3.1

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX A
CLIMATE ZONES AND PRESCRIPTIVE *BUILDING ENVELOPE* AND DUCT INSULATION TABLES

Tables A-1 through A-3 appear twice in this appendix. The three tables are shown first with I-P units, followed by three tables with SI units.

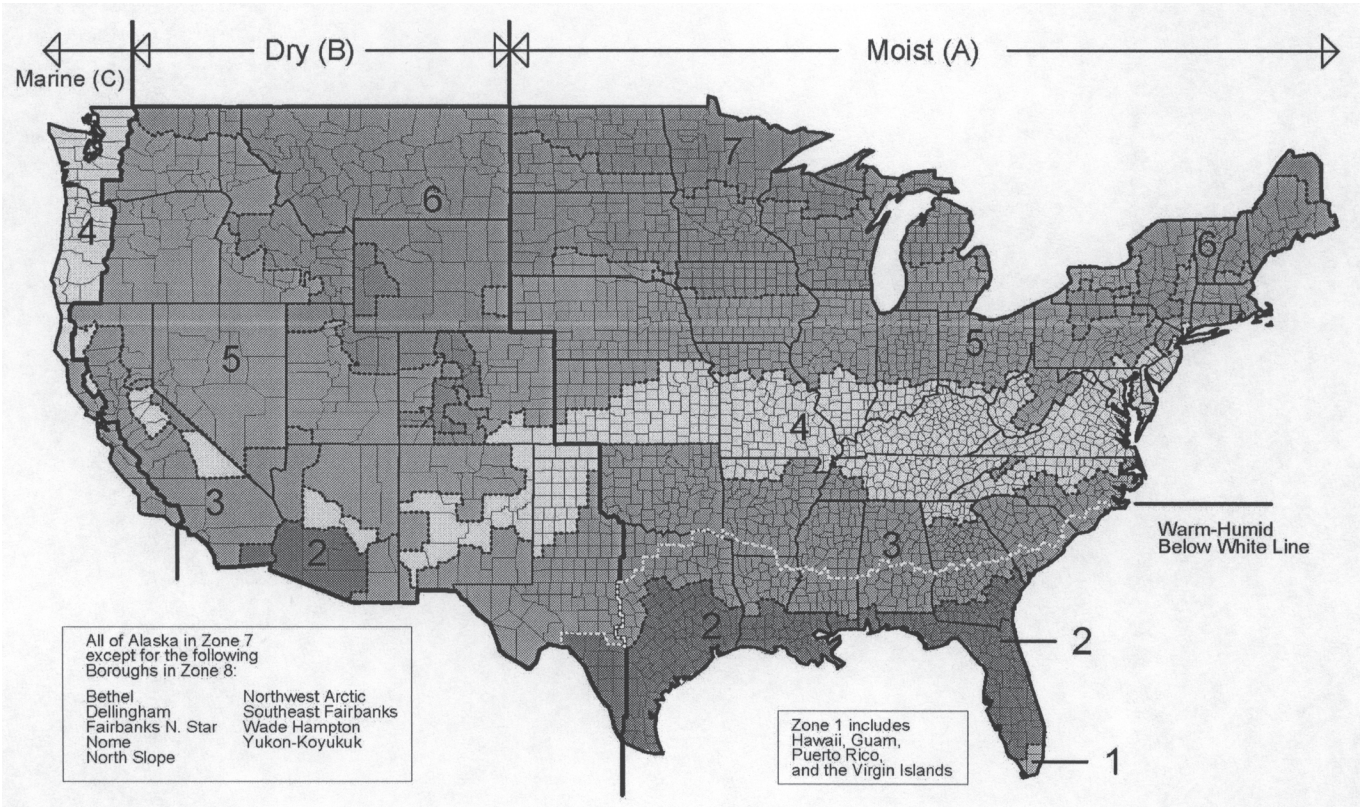
For *climate zones*, see Section 5.1.4 of ANSI/ASHRAE/IES Standard 90.1 and Normative Appendix B of ANSI/ASHRAE Standard 169.

a. For the United States, the ANSI/ASHRAE Standard 169 *climate zone* map is reproduced below. A list of counties and their respective *climate zones* can be found in Table B1 in ANSI/ASHRAE Standard 169.

b. For Canada, see Table B2 in ANSI/ASHRAE Standard 169.

c. For available international locations (outside the U.S. and Canada), see Table B3 in ANSI/ASHRAE Standard 169.

d. For locations not provided in Tables B2 or B3, see Table B4 (reproduced below) in ANSI/ASHRAE Standard 169 for the international *climate zone* definitions.



U.S. *Climate Zone* Map (*ASHRAE Transactions* 109(1), Briggs et al., 2003)

Climate Zone Number	Name	Thermal Criteria (I-P)	Thermal Criteria (SI)
1	Very hot—Humid (1A), Dry (1B)	9000 < CDD50°F	5000 < CDD10°C
2	Hot—Humid (2A), Dry (2B)	6300 < CDD50°F ≤ 9000	3500 < CDD10°C ≤5000
3A, 3B	Warm—Humid (3A), Dry (3B)	4500 < CDD50°F ≤ 6300	2500 < CDD10°C ≤ 3500
3C	Warm—Marine (3C)	CDD50°F ≤ 4500 and HDD65°F ≤ 3600	CDD10°C ≤ 2500 and HDD18°C ≤ 2000
4A, 4B	Mixed—Humid (4A), Dry (4B)	CDD50°F ≤ 4500 and 3600 < HDD65°F ≤ 5400	2500 ≤ CDD10°C and 2000 < HDD18°C ≤ 3000
4C	Mixed—Marine (4C)	3600 < HDD65°F ≤ 5400	2000 < HDD18°C ≤ 3000
5A, 5B, 5C	Cool—Humid (5A), Dry (5B), Marine (5C)	5400 < HDD65°F ≤ 7200	3000 < HDD18°C ≤ 4000
6A, 6B	Cold—Humid (6A), Dry (6B)	7200 < HDD65°F ≤ 9000	4000 < HDD18°C ≤ 5000
7	Very cold	9000 < HDD65°F ≤ 12600	5000 < HDD18°C ≤ 7000
8	Subarctic	12600 < HDD65°F	7000 < HDD18°C

TABLE A-1 (Supersedes Table A2.4.2 in ANSI/ASHRAE/IES Standard 90.1)
***Single-Rafter Roof* Requirements (I-P)**

	Minimum Insulation R-Value or Maximum Assembly U-Factor		
Climate Zone	*Nonresidential*	*Residential*	Semiheated
1	R-38 U-0.029	R-38 + R10 ci U-0.022	R-19 U-0.055
2	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-19 U-0.055
3, 4, 5	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-30 U-0.036
6	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-38 U-0.029
7, 8	R-38 + R15 ci U-0.020	R-38 + R15 ci U-0.020	R-38 U-0.029

TABLE A-2 (Supersedes Table 6.8.2-1 in ANSI/ASHRAE/IES Standard 90.1)
Minimum Duct Insulation R-Value[a] Heating- and Cooling-Only Supply Ducts and Return Ducts (I-P)

	Duct Location						
Climate Zone	Exterior	Ventilated Attic	Unvented Attic above Insulated Ceiling	Unvented Attic with *Roof* Insulation[a]	Unconditioned *Space*[b]	Indirectly Conditioned *Space*[c]	Buried
Heating-Only Ducts							
1, 2	None	None	None	None	None	None	None
3	R-6	None	None	None	R-6	None	None
4	R.6	None	None	None	R-6	None	None
5	R-8	R-6	None	None	R-6	None	R-6
6	R-8	R-8	R-6	None	R-6	None	R-6
7	R-10	R-8	R-8	None	R-6	None	R-6
8	R-10	R-10	R-8	None	R-8	None	R-8
Cooling-Only Ducts							
1	R-6	R-8	R-10	R-6	R-6	None	R-6
2	R-6	R-8	R-10	R-6	R-6	None	R-6
3	R-6	R-8	R-8	R-6	R-3.5	None	None
4	R-3.5	R-6	R-8	R-3.5	R-3.5	None	None
5, 6	R-3.5	R-3.5	R-6	R-3.5	R-3.5	None	None
7, 8	R-1.9	R-3.5	R-3.5	R-3.5	R-3.5	None	None
Return Ducts							
1 to 8	R-6	R-6	R-6	None	None	None	None

a. Insulation R-values, measured in (h·ft2·°F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 7.4.2. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

b. Includes crawl *spaces*, both ventilated and nonventilated.

c. Includes return air plenums with or without exposed *roofs* above.

TABLE A-3 (Supersedes Table 6.8.2-2 in ANSI/ASHRAE/IES Standard 90.1)
Minimum Duct Insulation R-Value[a] Combined Heating and Cooling Supply Ducts and Return Ducts (I-P)

	Duct Location						
Climate Zone	**Exterior**	**Ventilated Attic**	**Unvented Attic above Insulated Ceiling**	**Unvented Attic with *Roof* Insulation[a]**	**Unconditioned *Space*[b]**	**Indirectly *Conditioned Space*[c]**	**Buried**
Supply Ducts							
1	R-8	R-8	R-10	R-6	R-6	None	R-6
2	R-8	R-8	R-8	R-6	R-8	None	R-6
3	R-8	R-8	R-8	R-6	R-8	None	R-6
4	R-8	R-8	R-8	R-6	R-8	None	R-6
5	R-8	R-8	R-8	R-3.5	R-8	None	R-6
6	R-10	R-8	R-8	R-3.5	R-8	None	R-6
7	R-10	R-8	R-8	R-3.5	R-8	None	R-6
8	R-10	R11	R11	R-3.5	R-8	None	R-8
Return Ducts							
1 to 8	R-6	R-6	R-6	None	None	None	None

a. Insulation R-values, measured in $(h \cdot ft^2 \cdot °F)/Btu$, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 7.4.2. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

b. Includes crawl *spaces*, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above.

TABLE A-1 (Supersedes Table A2.4.2 in ANSI/ASHRAE/IES Standard 90.1)
***Single-Rafter Roof* Requirements (SI)**

	Minimum Insulation R-Value or Maximum Assembly U-Factor		
Climate Zone	***Nonresidential***	***Residential***	**Semiheated**
1	R-6.7 U-0.165	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
2	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
3, 4, 5	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-5.3 U-0.204
6	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-6.7 U-0.165
7, 8	R-6.7 + R-2.6 ci U-0.111	R-6.7 + R-2.6 ci U-0.111	R-6.7 U-0.165

TABLE A-2 (Supersedes Table 6.8.2A in ANSI/ASHRAE/IES Standard 90.1)
Minimum Duct Insulation R-Value[a] Heating- and Cooling-Only Supply Ducts and Return Ducts (SI)

	Duct Location						
Climate Zone	**Exterior**	**Ventilated Attic**	**Unvented Attic Above Insulated Ceiling**	**Unvented Attic with *Roof* Insulation[a]**	**Unconditioned *Space*[b]**	**Indirectly Conditioned *Space*[c]**	**Buried**
Heating-Only Ducts							
1, 2	None	None	None	None	None	None	None
3	R-1.06	None	None	None	R-1.06	None	None
4	R-1.06	None	None	None	R-1.06	None	None
5	R-1.41	R-1.06	None	None	R 1.06	None	R-1.06
6	R-1.41	R-1.41	R-1.06	None	R 1.06	None	R-1.06
7	R-1.76	R-1.41	R-1.41	None	R-1.06	None	R-1.06
8	R-1.76	R-10	R-1.41	None	R-1.41	None	R-1.41
Cooling-Only Ducts							
1	R-1.06	R-1.41	R-10	R-1.06	R-1.06	None	R-1.06
2	R-1.06	R-1.41	R-10	R-1.06	R-1.06	None	R-1.06
3	R-1.06	R-1.41	R-1.41	R-1.06	R-0.62	None	None
4	R-0.62	R-1.06	R-1.41	R-0.62	R-0.62	None	None
5, 6	R-0.62	R-0.62	R-1.06	R-0.62	R-0.62	None	None
7, 8	R-1.9	R-0.62	R-0.62	R-0.62	R-0.62	None	None
Return Ducts							
1 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

a. Insulation R-values, measured in $m^2 \cdot k/kW$, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 7.4.2. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 23.8 C at the installed thickness.

b. Includes crawl *spaces*, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above.

TABLE A-3 (Supersedes Table 6.8.2A in ANSI/ASHRAE/IES Standard 90.1)
Minimum Duct Insulation R-Value[a] Combined Heating and Cooling Supply Ducts and Return Ducts (SI)

	Duct Location						
Climate Zone	**Exterior**	**Ventilated Attic**	**Unvented Attic above Insulated Ceiling**	**Unvented Attic with *Roof* Insulation[a]**	**Unconditioned *Space*[b]**	**Indirectly *Conditioned Space*[c]**	**Buried**
Supply Ducts							
1	R-1.41	R-1.41	R-1.76	R-1.06	R-1.06	None	R-1.06
2	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
3	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
4	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
5	R-1.41	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
6	R-1.76	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
7	R-1.76	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
8	R-1.76	R-1.94	R-1.94	R-0.62	R-1.41	None	R-1.41
Return Ducts							
1 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

a. Insulation R-values, measured in $m^2 \cdot k/kW$, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 7.4.2. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 23.8 C at the installed thickness."

b. Includes crawl *spaces*, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above.

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX B
PRESCRIPTIVE EQUIPMENT EFFICIENCY TABLES FOR THE ALTERNATE REDUCED RENEWABLES AND INCREASED EQUIPMENT EFFICIENCY APPROACH IN SECTION 7.4.1.1.2

Informative Note: The first 14 tables appear in I-P units and are followed by 14 tables in SI units. Table B-15, following Table B-14 (I-P), is in SI units only; there is no I-P version.

TABLE B-1 (Supersedes Table 6.8.1-1 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary Air Conditioners and Condensing Units (I-P)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air-cooled	<65,000 Btu/h (one phase)	All	Split systems	14.0 SEER 12.0 EER	AHRI 210/240
			Single packaged	14.0 SEER 11.6 EER	
	<65,000 Btu/h (three phase)	All	Split systems	14.0 SEER 12.0 EER	
			Single packaged	14.0 SEER 11.6 EER	
Through-the-wall, air-cooled	<30,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small-duct high-velocity, air-cooled	<65,000 Btu/h (one phase)	All	Split systems	11.0 SEER before 1/1/2015 12.0 SEER after 1/1/2015	
	<65,000 Btu/h (3 phase)	All	Split systems	11.0 SEER	
Air conditioners air-cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	11.7 EER 13.0 IEER	AHRI 340/360
		All other	Split systems and single packaged	11.5 EER 12.8 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	11.7 EER 12.5 IEER	
		All other	Split systems and single packaged	11.5 EER 12.3 IEER	
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	10.5 EER 11.3 IEER	
		All other	Split systems and single packaged	10.3 EER 11.1 IEER	
	≥760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	9.9 EER 11.1 IEER	
		All other	Split systems and single packaged	9.7 EER 10.9 IEER	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-1 (Supersedes Table 6.8.1-1 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary Air Conditioners and Condensing Units (I-P) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, water-cooled	<65,000 Btu/h	All	Split systems and single packaged	14.0 EER 14.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single packaged	13.8 EER 15.1 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
	≥760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
Air conditioners, evaporatively cooled	<65,000 Btu/h	All	Split systems and single packaged	14.0 EER 14.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single packaged	13.8 EER 15.1 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
	≥240,000 Btu/h and <760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
	≥760,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	14.0 EER 14.8 IEER	
		All other	Split systems and single packaged	13.8 EER 14.6 IEER	
Condensing units, air-cooled	≥135,000 Btu/h			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	≥135,000 Btu/h			Not applicable match with indoor coil	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-2 (Supersedes Table 6.8.1-2 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary and Applied Heat Pumps Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air cooled (cooling mode)	<65,000 Btu/h (one phase)	All	Split systems	14.0 SEER 12.0 EER	AHRI 210/240
			Single packaged	14.0 SEER 11.6 EER	
	<65,000 Btu/h (three phase)	All	Split systems	14.0 SEER 12.0 EER	
			Single packaged	14.0 SEER 11.6 EER	
Through the wall, air cooled (cooling mode)	<30,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small duct high velocity, air cooled (cooling mode)	<65,000 Btu/h (one phase)	All	Split systems	11.0 SEER before 1/1/2015 12.0 SEER after 1/1/2015	
	<65,000 Btu/h (three phase)	All	Split systems	11.0 SEER	
Air conditioners, air cooled (cooling mode)	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	11.3 EER 12.3 IEER	AHRI 340/360
		All other	Split systems and single packaged	11.1EER 12.1 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	10.9 EER 11.9 IEER	
		All other	Split systems and single packaged	10.7 EER 11.7 IEER	
	≥240,000 Btu/h	Electric resistance (or none)	Split systems and single packaged	10.3 EER 10.9 IEER	
		All other	Split systems and single packaged	10.1 EER 10.7 IEER	
Water to air water loop (cooling mode)	<17,000 Btu/h	All	86°F entering water	14.0 EER	ISO-13256-1
	≥17,000 Btu/h and <65,000 Btu/h	All	86°F entering water	14.0 EER	
	>65,000 Btu/h and <135,000 Btu/h	All	86°F entering water	14.0 EER	
Water to air ground water (cooling mode)	<135,000 Btu/h	All	59°F entering water	18.0 EER	
Water to air ground loop (cooling mode)	<135,000 Btu/h	All	77°F entering water	14.1 EER	
Water to water water loop (cooling mode)	<135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water to water groundwater (cooling mode)	<135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine to water ground loop cooing mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-2 (Supersedes Table 6.8.1-2 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary and Applied Heat Pumps Minimum Efficiency Requirements (I-P) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air cooled (heating mode)	<65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	9.0 HSPF	AHRI 210/240
			Single packaged	8.5 HSPF	
	<65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	9.0 HSPF	
			Single packaged	8.5 HSPF	
Through the wall, air cooled (heating mode)	<30,000 Btu/h (cooling capacity)	All	Split systems	7.4 HSPF	
			Single packaged	7.4 HSPF	
Small duct high velocity, air cooled (heating mode)	<65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	6.8 HSPF before 1/1/2015 7.2 HSPF after 1/1/2015	
	<65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	6.8 HSPF	
Air cooled (heating mode)	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)		47°F DB/43°F wb *outdoor air*	3.3 COP_H	AHRI 340/360
			17°F DB/15°F wb *outdoor air*	2.25 COP_H	
	≥135,000 Btu/h (cooling capacity)		47°F DB/43°F wb *outdoor air*	3.2 COP_H	
			17°F DB/15°F wb *outdoor air*	2.05 COP_H	
Water to air water loop (heating mode)	<135,000 Btu/h (cooling capacity)		68°F entering water	4.3COP_H	ISO-13256-1
Water to air groundwater (heating mode)	<135,000 Btu/h (cooling capacity)		50°F entering water	3.7 COP_H	
Brine to air ground loop (heating mode)	<135,000 Btu/h (cooling capacity)		32°F entering fluid	3.2 COP_H	
Water to water water loop (heating mode)	<135,000 Btu/h (cooling capacity)		68°F entering water	3.7 COP_H	ISO-13256-2
Water to water groundwater (heating mode)	<135,000 Btu/h (cooling capacity)		50°F entering water	3.1 COP_H	
Brine to water ground loop (heating Mode)	<135,000 Btu/h (cooling capacity)		32°F entering fluid	2.5 COP_H	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-3 (Supersedes Table 6.8.1-3 in ANSI/ASHRAE/IES Standard 90.1-2013)
Water-Chilling Packages—Efficiency Requirements (I-P)[a,b,e]

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure[c]
Air-cooled chillers	<150 tons	EER (Btu/W)	≥10.100 FL	≥9.700 FL	AHRI 550/590
			≥13.700 IPLV	≥15.800 IPLV	
	≥150 tons		≥10.100 FL	≥9.700 FL	
			≥14.000 IPLV	≥16.100 IPLV	
Air cooled without condenser, electrically operated	All capacities	EER (Btu/W)	Condenserless units shall comply with air-cooled chiller requirement with matched condensers.		
Water cooled, electrically operated positive displacement	<75 tons	kW/ton	≤0.750 FL	≤0.780 FL	
			≤0.600 IPLV	≤0.500 IPLV	
	≥75 tons and <150 tons		≤0.720 FL	≤0.750 FL	
			≤0.560 IPLV	≤0.490 IPLV	
	≥150 tons and <300 tons		≤0.660 FL	≤0.680 FL	
			≤0.540 IPLV	≤0.440 IPLV	
	≥300 tons and <600 tons		≤0.610 FL	≤0.625 FL	
			≤0.520 IPLV	≤0.410 IPLV	
	≥600 tons		≤0.560 FL	≤0.585 FL	
			≤0.500 IPLV	≤0.380 IPLV	
Water cooled, electrically operated centrifugal[f]	<150 tons	kW/ton	≤0.610 FL	≤0.695 FL	
			≤0.550 IPLV	≤0.440 IPLV	
	≥150 tons and <300 tons		≤0.610 FL	≤0.635 FL	
			≤0.550 IPLV	≤0.400 IPLV	
	≥300 tons and <400 tons		≤0.560 FL	≤0.595 FL	
			≤0.520 IPLV	≤0.390 IPLV	
	≥400 tons and <600 tons		≤0.560 FL	≤0.585 FL	
			≤0.500 IPLV	≤0.380 IPLV	
	≥600 tons		≤0.560 FL	≤0.585 FL	
			≤0.500 IPLV	≤0.380 IPLV	

a. The requirements for centrifugal chiller shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed in AHRI 550/590. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

c. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

d. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

e. FL is the full-load performance requirements and IPLV is for the part-load performance requirements.

f. Centrifugal chillers that are not designed for operation at AHRI Standard 550/590 test conditions of 44°F leaving chilled-fluid temperature and 2.4 gpm/ton evaporator fluid flow and 85°F entering condenser-fluid temperature with 3.0 gpm/ton condenser-fluid flow (and thus cannot be tested to meet the requirements of Table B-3) shall have maximum full-load kW/ton (FL) and NPLV part-load ratings requirements adjusted using the following equations:

$$FL_{adj} = FL/K_{adj}$$

$$PLV_{adj} = IPLV/K_{adj}$$

$$K_{adj} = A \times B$$

where

FL = full-load kW/ton value from Table B-3

FL_{adj} = maximum full-load kW/ton rating, adjusted for nonstandard conditions

IPLV = IPLV value from Table B-3

PLV_{adj} = maximum NPLV rating, adjusted for nonstandard conditions

$A = 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.9302$

$B = 0.0015 \times LvgEvap + 0.934$

LIFT = LvgCond – LvgEvap

LvgCond = full-load condenser leaving fluid temperature, °F

LvgEvap = full-load evaporator leaving temperature, °F

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum evaporator leaving temperature:36°F
- Maximum condenser leaving temperature:115°F
- 20°F ≤ LIFT ≤ 80°F

TABLE B-3 (Supersedes Table 6.8.1-3 in ANSI/ASHRAE/IES Standard 90.1-2013)
Water-Chilling Packages—Efficiency Requirements (I-P)[a,b,e] *(Continued)*

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure[c]
Air-cooled absorption, single effect	All capacities	COP	≥0.600 FL	NA[d]	AHRI 560
Water-cooled absorption, single effect	All capacities	COP	≥0.700 FL	NA[d]	
Absorption double effect, indirect fired	All capacities	COP	≥1.000 FL ≥1.050 IPLV	NA[d]	
Absorption double effect, direct fired	All capacities	COP	≥1.000 FL ≥1.000 IPLV	NA[d]	

a. The requirements for centrifugal chiller shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed in AHRI 550/590. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

c. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

d. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

e. FL is the full-load performance requirements and IPLV is for the part-load performance requirements.

f. Centrifugal chillers that are not designed for operation at AHRI Standard 550/590 test conditions of 44°F leaving chilled-fluid temperature and 2.4 gpm/ton evaporator fluid flow and 85°F entering condenser-fluid temperature with 3.0 gpm/ton condenser-fluid flow (and thus cannot be tested to meet the requirements of Table B-3) shall have maximum full-load kW/ton (FL) and NPLV part-load ratings requirements adjusted using the following equations:

$$FL_{adj} = FL/K_{adj}$$

$$PLV_{adj} = IPLV/K_{adj}$$

$$K_{adj} = A \times B$$

where

FL = full-load kW/ton value from Table B-3

FL_{adj} = maximum full-load kW/ton rating, adjusted for nonstandard conditions

IPLV = IPLV value from Table B-3

PLV_{adj} = maximum NPLV rating, adjusted for nonstandard conditions

A = $0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.9302$

B = $0.0015 \times LvgEvap + 0.934$

LIFT = LvgCond – LvgEvap

LvgCond = full-load condenser leaving fluid temperature, °F

LvgEvap = full-load evaporator leaving temperature, °F

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum evaporator leaving temperature:36°F
- Maximum condenser leaving temperature:115°F
- 20°F ≤ LIFT ≤ 80°F

TABLE B-4 (Supersedes Table 6.8.1-4 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single Packaged Vertical Air Conditioners, Single Packaged Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
PTAC (cooling mode) new construction	<7,000 Btu/h	95°F db *outdoor air*	11.9 EER	ARI 310/380
	≥7,000 Btu/h and <10,000 Btu/h	95°F db *outdoor air*	11.3 EER	
	≥10,000 Btu/h and <13,000 Btu/h	95°F db *outdoor air*	10.7 EER	
	≥13,000 Btu/h	95°F db *outdoor air*	9.5 EER	
PTAC (cooling mode) replacement[b]	<7,000 Btu/h	95°F db *outdoor air*	11.9 EER	ARI 310/380
	≥7,000 Btu/h and <10,000 Btu/h	95°F db *outdoor air*	11.3 EER	
	≥10,000 Btu/h and <13,000 Btu/h	95°F db *outdoor air*	10.7 EER	
	≥13,000 Btu/h	95°F db *outdoor air*	9.5 EER	
PTHP (cooling mode) new construction	<7,000 Btu/h	95°F db *outdoor air*	11.7 EER	ARI 310/380
	≥7,000 Btu/h and <10,000 Btu/h	95°F db *outdoor air*	11.1 EER	
	≥10,000 Btu/h and <13,000 Btu/h	95°F db *outdoor air*	10.5 EER	
	≥13,000 Btu/h	95°F db *outdoor air*	9.3 EER	
PTHP (heating mode) new construction	All capacities	95°F db *outdoor air*	2.8 COP	ARI 310/380
PTHP (cooling mode) replacement[b]	<7,000 Btu/h	95°F db *outdoor air*	11.7 EER	ARI 310/380
	≥7,000 Btu/h and <10,000 Btu/h	95°F db *outdoor air*	11.1 EER	
	≥10,000 Btu/h and <13,000 Btu/h	95°F db *outdoor air*	10.5 EER	
	≥13,000 Btu/h	95°F db *outdoor air*	9.3 EER	
PTHP (heating mode) replacement[b]	All capacities	95°F db *outdoor air*	2.8 COP	ARI 310/380

a. Section 11 contains a complete specification of the referenced test procedures, including year version of the test procedure.
b. Replacement units shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 in. high and less than 42 in. wide.

TABLE B-5 (Supersedes Table 6.8.1-4 in ANSI/ASHRAE/IES Standard 90.1)
Single Packaged Vertical Air Conditioners, Single Packaged Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements (I-P)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
SPVAC (cooling mode)	<65,000 Btu/h	95°F db/75°F wb *outdoor air*	14.0 SEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.2 EER 12.9 IEER	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.4 IEER	
SPVHP (cooling mode)	<65,000 Btu/h	95°F db/75°F wb *outdoor air*	14.0 SEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	95°F db/75°F wb *outdoor air*	11.0 EER 12.2 IEER	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h	95°F db/75°F wb *outdoor air*	10.6 EER 11.6 IEER	
SPVHP (heating mode)	<65,000 Btu/h	47°F db/43°F wb *outdoor air*	8.0 HSPF	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	47°F db/43°F wb *outdoor air*	3.3 COP_H	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h	47°F db/43°F wb *outdoor air*	3.2 COP_H	
Room air conditioners with louvered sides	<6000 Btu/h		10.7 SEER	ANSI/AHAM RAC-1
	≥6000 Btu/h and <8000 Btu/h		10.7 EER	
	≥8000 Btu/h and <14,000 Btu/h		10.8 EER	
	14000 Btu/h and <20,000 Btu/h		10.7 EER	
	≥20,000 Btu/h		9.4 EER	
Room air conditioners without louvered sides	<8000 Btu/h		9.9 EER	
	≥8000 Btu/h and <20,000 Btu/h		9.4 EER	
	≥20,000 Btu/h		9.3 EER	
Room air conditioner heat pump with louvered sides	<20,000 Btu/h		9.9 EER	
	≥20,000 Btu/h		9.3 EER	
Room air conditioner heat pump without louvered sides	<14,000 Btu/h		9.4 EER	
	≥14,000 Btu/h		8.8 EER	
Room air conditioner, casement only	All capacities		9.6 EER	
Room air conditioner, casement-slider	All capacities		10.5 EER	

a. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

TABLE B-6 (Supersedes Table 6.8.1-5 in ANSI/ASHRAE/IES Standard 90.1)
Warm Air Furnace and Combustion Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces, and Unit Heaters (I-P)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Test Procedure[b]	Minimum Efficiency[a]
Warm air furnace, gas fired (weatherized)	<225,000 Btu/h	Maximum capacity[d]	DOE 10 CFR Part 430 or ANSI Z21.47	78% AFUE or 80% E_t[c,e]
	>225,000 Btu/h	Maximum capacity[d]	ANSI Z21.47	80% E_c[c,e]
Warm air furnace, gas fired (nonweatherized)	<225,000 Btu/h	Maximum capacity[d]	DOE 10 CFR Part 430 or ANSI Z21.47	90% AFUE or 92% E_t[c,e]
	>225,000 Btu/h	Maximum capacity[d]	ANSI Z21.47	92% E_c[c,e]
Warm air furnace, oil fired (weatherized)	<225,000 Btu/h	Maximum capacity[d]	DOE 10 CFR Part 430 or UL 727	78% AFUE or 80% E_t[c,e]
	>225,000 Btu/h	Maximum capacity[d]	UL 727	81% E_t[e]
Warm air furnace, oil fired (nonweatherized)	<225,000 Btu/h	Maximum capacity[d]	DOE 10 CFR Part 430 or UL 727	85% AFUE or 87%% E_t[c,e]
	>225,000 Btu/h	Maximum capacity[d]	UL 727	87% E_t[e]
Warm air duct furnaces, gas fired (weatherized)	All capacities	Maximum capacity[d]	ANSI Z83.9	80% E_c[f]
Warm air duct furnaces, gas fired (nonweatherized)	All capacities	Maximum capacity[d]	ANSI Z83.9	90% E_c[f]
Warm air unit heaters, gas fired (nonweatherized)	All capacities	Maximum capacity[d]	ANSI Z83.8	90% E_c[f,g]
Warm air unit heaters, oil fired (nonweatherized)	All capacities	Maximum capacity[d]	UL 731	90% E_c[f,g]

a. E_t = thermal efficiency. See test procedure for detailed discussions.

b. Section 11 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c. Combustion units not covered by NAECA (three-phase power or cooling capacity greater than or equal to 65,000 Btu/h) is allowed to comply with either rating.

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

e. Units shall also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or flue damper. A vent damper is an acceptable alternative to the flue damper for those furnaces where combustion air is drawn from the *conditioned space*.

f. E_c = combustion efficiency (100% less flue losses). See test procedures for detailed discussion.

g. As of August 8, 2008, according to the Energy Policy Act of 2005, units shall also include an interrupted or intermittent ignition devices (IID) and have either power venting or *automatic* flue dampers. A vent damper is an acceptable alternative to a flue damper for those unit heaters where combustion air is drawn from the *conditioned space*.

TABLE B-7 (Supersedes Table 6.8.1-6 in ANSI/ASHRAE/IES Standard 90.1)
Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements (I-P)

Equipment Type[a]	Subcategory or Rating Condition	Size Category (Input)	Efficiency[b,c]	Test Procedure[g]
Boilers, hot water	Gas fired	<300,000 Btu/h[h,i]	89% AFUE[f,h]	10 CFR Part 430
		≥300,000 Btu/h and ≤2,500,000 Btu/h[d]	89% E_t[f]	10 CFR Part 431
		>2,500,000 Btu/h[a]	91% E_c[f]	
	Oil fired[e]	<300,000 Btu/h	89% AFUE[f]	10 CFR Part 430
		≥300,000 Btu/h and ≤2,500,000 Btu/h[d]	85% E_t[f]	10 CFR Part 431
		>2,500,000 Btu/h[a]	86% E_c[f]	
Boilers, steam	Gas fired	<300,000 Btu/h[i]	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h[d]	79% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a]	79% E_t	
	Gas fired natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h[d]	77% E_t	
		>2,500,000 Btu/h[a]	77% E_t	
	Oil fired[e]	<300,000 Btu/h	82% AFUE	10 CFR Part 430
		≥300,000 Btu/h and ≤2,5000,000 Btu/h[d]	81% E_t	10 CFR Part 431
		>2,500,000 Btu/h[a]	81% E_t	

a. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.

c. E_t = thermal efficiency. See reference document for detailed information.

d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.

e. Includes oil fired (residual).

f. Systems shall be designed with lower operating return hot-water temperatures (<130°F) and use hot-water reset to take advantage of the much higher efficiencies of condensing boilers.

g. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

i. Boilers shall not be equipped with a continuous pilot ignition system.

TABLE B-8 (Supersedes Table 6.8.1-7 in ANSI/ASHRAE/IES Standard 90.1)
Performance Requirements for Heat-Rejection Equipment (I-P)

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Conditions[g]	Performance Required [a,b,c,d,e,f,i]	Test Procedure[h]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥22.0 gpm/hp	CTI ATC-105and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥15.0 gpm/hp	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥8.0 gpm/hp	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥134,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥110,000 Btu/h·hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥157,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥135,000 Btu/h·hp	CTI ATC-106
Air-cooled condensers	All	190°F entering gas temperature 125°F condensing temperature 15°F subcooling 95°F entering wb	≥176,000 Btu/h·hp	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B-8 divided by the fan motor nameplate power.

b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B-8 divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

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

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

f. All cooling towers, closed-circuit coolers, evaporative condensers, and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.

g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.

h. Informative Appendix G contains information on the referenced test procedures.

i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in Table B-3.

TABLE B-9 (Supersedes Table 7.8 in ANSI/ASHRAE/IES Standard 90.1)
Performance Requirements for Water Heating Equipment (I-P)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required [a]	Test Procedure [b]
Electric table-top water heaters	≤12 kW	Resistance ≥20 gal	EF ≥ 0.93 – 0.00132V	DOE 10 CFR Part 430
Electric water heaters	12 kW[e]	Resistance ≥20 gal	EF ≥ 0.97 – 0.00132V	DOE 10 CFR Part 430
	>12 kW	Resistance ≥20 gal	SL ≤ 0.3 + 27$\sqrt{V}$, Btu/h	ANSI Z21.10.3
	All sizes	Heat pump	EF ≥ 2.0	DOE 10 CFR Part 430
Gas storage water heaters[f]	≤75,000 Btu/h	≥20 gal	E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/800 + 110 $\sqrt{V}$), Btu/h	DOE 10 CFR Part 430
	>75,000 Btu/h	<4000 (Btu/h)/gal	E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/800 + 110 $\sqrt{V}$), Btu/h	ANSI Z21.10.3
Gas instantaneous water heaters	>50,000 Btu/h and <200,000 Btu/h[d]	≥4000 (Btu/h)/gal and <2 gal	E_t ≥ 0.94 or EF ≥ 0.93	DOE 10 CFR Part 430
	≥200,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	E_t ≥ 0.94 or EF ≥ 0.93	ANSI Z21.10.3
	≥200,000 Btu/h	4000 (Btu/h)/gal and ≥10 gal	E_t ≥ 0.94 or EF ≥ 0.93	
Oil storage water heaters	≤105,000 Btu/h	≥20 gal	EF ≥ 0.59 – 0.0019V	DOE 10 CFR Part 430
	>105,000 Btu/h	<4000 (Btu/h)/gal	E_t ≥ 80% and SL ≤ (Q/799 + 16.6$\sqrt{V}$), Btu/h	ANSI Z21.10.3
Oil instantaneous water heaters	≤210,000 Btu/h	≥4000 (Btu/h)/gal and <2 gal	EF ≥ 0.59 – 0.0019V	DOE 10 CFR Part 430
	>210,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	E_t ≥ 80%	ANSI Z21.10.3
	>210,000 Btu/h	≥4000 (Btu/h)/gal and ≥10 gal	E_t ≥ 78% and SL ≤ (Q/799 + 16.6 $\sqrt{V}$), Btu/h	
Hot-water supply boilers, gas and oil	300,000 Btu/h and <12,500,000 Btu/h	≥4000 (Btu/h)/gal and <10 gal	E_t ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥4000 (Btu/h)/gal and ≥10 gal	E_t ≥ 80% and SL ≤ (Q/799 + 16.6 $\sqrt{V}$), Btu/h	
Hot-water supply boilers, oil		≥4000 (Btu/h)/gal and ≥10 gal	E_t ≥ 78% and SL ≤ (Q/799 + 16.6 $\sqrt{V}$), Btu/h	
Pool heaters, oil and gas	All sizes		E_t ≥ 78%	ASHRAE 146
Heat pump pool heaters	All sizes		≥4.0 COP	ASHRAE 146
Unfired storage tanks	All sizes		≥R-12.5	(none)

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.

b. Section 11 contains a details on the referenced test procedures, including the year version, of the referenced test procedure.

c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."

d. Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures of 180°F or higher.

e. Electric water heaters with input rates below 12 kW must comply with these requirements if the water heater is designed to heat water to temperatures of 180°F or higher.

f. Refer to ANSI/ASHRAE/IES Standard 90.1, Section 7.5.3, for additional requirements for gas storage and instantaneous water heaters and gas hot-water supply boilers.

TABLE B-10 Commercial Refrigerator and Freezers (I-P)

Equipment Type	Application	Energy Use Limit (kW/h per day)[a]
Refrigerators with solid doors	Holding temperature	$0.10V + 2.04$
Refrigerators with transparent doors		$0.12V + 3.34$
Freezers with solid doors		$0.40V + 1.38$
Freezers with transparent doors		$0.75V + 4.10$
Refrigerators/freezers with solid doors		Greater of $0.12V + 3.34$ or 0.70
Commercial refrigerators	Pulldown	$0.126V + 3.51$

a. V is the chiller or frozen compartment volume (L) as defined in the Association of Home Appliance Manufacturers Standard HRF1-1979.

TABLE B-11 Commercial Clothes Washers (I-P)

Product	MEF[a]	WF[b], gal/ft^3
All commercial clothes washers	1.72	4.0

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.
b. *WF = water factor* (in gal/ft^3).

TABLE B-12 Supersedes Table 6.8.1-9 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Variable-Refrigerant-Flow (VRF) Air Conditioners Minimum Efficiency (I-P)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air conditioners, air cooled	<65,000 Btu/h	All	VRF multisplit system	14.0 SEER 12.0 EER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.9 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.4 IEER	
	≥240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 13.0 IEER	

a. Section 11 contains details for the referenced test procedure, including year version of the test procedure.

TABLE B-13 (Supersedes Table 6.8.1-10 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Variable-Refrigerant-Flow (VRF) Heat-Pump Air Conditioners Minimum Efficiency (I-P)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air cooled (cooling mode)	<65,000 Btu/h	All	VRF multisplit system	14.0 SEER 12.0 EER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.3 EER 14.2 IEER	
	≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	11.1 EER 14.0 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.9 EER 13.7 IEER	
	≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.7 EER 13.5 IEER	
	≥240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 12.5 IEER	
	≥240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.1 EER 12.3 IEER	
VRF water source (cooling mode)	<65,000 Btu/h	All	VRF multisplit systems 86°F entering water	14.0 EER	AHRI 1230
	<65,000 Btu/h	All	VRF multisplit systems with heat recovery 86°F entering water	13.8 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF multisplit system 86°F entering water	14.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	13.8 EER	
	≥135,000 Btu/h	All	VRF multisplit system 86°F entering water	11.6 EER	
	≥135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	11.2 EER	
VRF groundwater source (cooling mode)	<135,000 Btu/h	All	VRF multisplit system 59°F entering water	16.2 EER	AHRI 1230
	<135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	16.0 EER	
	≥135,000 Btu/h	All	VRF multisplit system 59°F entering water	13.8 EER	
	≥135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	13.6 EER	
VRF ground source (cooling mode)	<135,000 Btu/h	All	VRF multisplit system 77°F entering water	13.4 EER	AHRI 1230
	<135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	13.2 EER	
	≥135,000 Btu/h	All	VRF multisplit system 77°F entering water	11.0 EER	
	≥135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	10.8 EER	

a. Section 11 contains details for the referenced test procedure, including year version of the test procedure.

TABLE B-13 (Supersedes Table 6.8.1-10 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Variable-Refrigerant-Flow (VRF) Heat-Pump Air Conditioners Minimum Efficiency (I-P) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air cooled (heating mode)	<65,000 Btu/h (cooling capacity)	—	VRF multisplit system	8.5 HSPF	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb *outdoor air*	3.40 COP_H	
			17°F db/15°F wb *outdoor air*	2.40 COP_H	
	≥135,000 Btu/h (cooling capacity)	—	VRF multisplit system 47°F db/43°F wb *outdoor air*	3.20 COP_H	
			17°F db/15°F wb *outdoor air*	2.10 COP_H	
VRF water source (heating mode)	<135,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	4.60 COP_H	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	—	VRF multisplit system 68°F entering water	4.20 COP_H	
VRF groundwater source (heating mode)	<135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.60 COP_H	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	—	VRF multisplit system 50°F entering water	3.30 COP_H	
VRF ground source (heating mode)	<135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering fluid	3.10 COP_H	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	—	VRF multisplit system 32°F entering fluid	2.80 COP_H	

a. Section 11 contains details for the referenced test procedure, including year version of the test procedure.

TABLE B-14 Commercial Refrigeration Minimum Efficiency Requirements (I-P Units)

Equipment Type					
Equipment Class[a]	**Family Code**	**Operating Mode**	**Rating Temperature**	**Energy Use Limits, kWh/day, as of 1/1/2012[b,c]**	**Test Procedure**
VOP.RC.M	Vertical open	Remote condensing	Medium temperature	0.82 × TDA + 4.07[d]	
SVO.RC.M	Semivertical open	Remote condensing	Medium temperature	0.83 × TDA + 3.18[d]	
HZO.RC.M	Horizontal open	Remote condensing	Medium temperature	0.35 × TDA + 2.88[d]	
VOP.RC.L	Vertical open	Remote condensing	Low temperature	2,27 × TDA + 6.85[d]	
HZO.RC.L	Horizontal open	Remote condensing	Low temperature	0.57 × TDA + 6.88[d]	
VCT.RC.M	Vertical transparent door	Remote condensing	Medium temperature	0.22 × TDA + 1.95	
VCT.RC.L	Vertical transparent door	Remote condensing	Low temperature	0.56 × TDA + 2.61	
SOC.RC.M	Service over counter	Remote condensing	Medium temperature	0.51 × TDA + 0.11	
VOP.SC.M	Vertical open	Self contained	Medium temperature	1.74 × TDA + 4.71[d]	
SVO.SC.M	Semivertical open	Self contained	Medium temperature	1.73 × TDA + 4.59[d]	
HZO.SC.M	Horizontal open	Self contained	Medium temperature	0.77 × TDA + 5.55[d]	AHRI 1200
HZO.SC.L	Horizontal open	Self contained	Low temperature	1.92 × TDA + 7.08[d]	
VCT.SC.I	Vertical transparent door	Self contained	Ice cream	0.67 × TDA + 3.29	
VCS.SC.I	Vertical solid door	Self contained	Ice cream	0.38 × V + 0.88	
HCT.SC.I	Horizontal transparent door	Self contained	Ice cream	0.56 × TDA + 0.43	
SVO.RC.L	Semivertical open	Remote condensing	Low temperature	2.27 × TDA + 6.85[d]	
VOP.RC.I	Vertical open	Remote condensing	Ice cream	2.89 × TDA + 8.7[d]	
SVO.RC.I	Semivertical open	Remote condensing	Ice cream	2.89 × TDA + 8.7[d]	
HZO.RC.I	Horizontal open	Remote condensing	Ice cream	0.72 × TDA + 8.74[d]	
VCT.RC.I	Vertical transparent door	Remote condensing	Ice cream	0.66 × TDA + 3.05	
HCT.RC.M	Horizontal transparent door	Remote condensing	Medium temperature	0.16 × TDA + 0.13	
HCT.RC.L	Horizontal transparent door	Remote condensing	Low temperature	0.34 × TDA + 0.26	
HCT.RC.I	Horizontal transparent door	Remote condensing	Ice cream	0.4 × TDA + 0.31	
VCS.RC.M	Vertical solid door	Remote condensing	Medium temperature	0.11 × V + 0.26	
VCS.RC.L	Vertical solid door	Remote condensing	Low temperature	0.23 × V + 0.54	
VCS.RC.I	Vertical solid door	Remote condensing	Ice cream	0.27 × V + 0.63	
HCS.RC.M	Horizontal solid door	Remote condensing	Medium temperature	0.11 × V + 0.26	
HCS.RC.L	Horizontal solid door	Remote condensing	Low temperature	0.23 × V + 0.54	
HCS.RC.I	Horizontal solid door	Remote condensing	Ice cream	0.27 × V + 0.63	
SOC.RC.L	Service over counter	Remote condensing	Low temperature	1.08 × TDA + 0.22	AHRI 1200
SOC.RC.I	Service over counter	Remote condensing	Ice cream	1.26 × TDA + 0.26	
VOP.SC.L	Vertical open	Self contained	Low temperature	4.37 × TDA + 11.82[d]	
VOP.SC.I	Vertical open	Self contained	Ice cream	5.55 × TDA + 15.02[d]	
SVO.SC.L	Semivertical open	Self contained	Low temperature	4.34 × TDA + 11.51[d]	
SVO.SC.I	Semivertical open	Self contained	Ice cream	5.52 × TDA + 14.63[d]	
HZO.SC.I	Horizontal open	Self contained	Ice cream	2.44 × TDA + 9.0 [d]	
SOC.SC.I	Service over counter	Self contained	Ice cream	1.76 × TDA + 0.36	
HCS.SC.I	Horizontal solid door	Self contained	Ice cream	0.38 × V + 0.88	

a. Equipment class designations consist of a combination (in sequential order separated by periods (AAA).(BB).(C) of the following:

(AAA) An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical transparent doors, VCS = vertical solid doors, HCT = horizontal transparent doors, HCS = horizontal solid doors, or SOC = service over counter)

(BB) An operating mode code (RC = remote condensing or SC = self contained)

(CC) A rating temperature code (M = medium temperature [38°F], L = low temperature [0°F], or I = ice-cream temperature [15°F])

For example, "VOP.RC.M" refers to the "vertical open, remote condensing, medium temperature" equipment class.

b. V (ft^3) is the volume of the case, as measured in AHRI Standard 1200, Appendix C.

c. TDA (ft^2) is the total display area of the case, as measured in AHRI Standard 1200, Appendix D.

d. Open refrigerated display cases shall be covered by field-installed strips, curtains, or doors.

TABLE B-15 ***Low-Voltage Dry-Type Distribution Transformers***
Minimum Nominal Efficiencies by Transformer Rating in Kilovolt-Amperes (kVA)

Single-Phase		Three-Phase	
kVA	**Efficiency[a]**	**kVA**	**Efficiency[a]**
15	98.39%	15	97.90%
25	98.60%	30	98.25%
37.5	98.74%	45	98.39%
50	98.81%	75	98.60%
75	98.95%	112.5	98.74%
100	99.02%	150	98.81%
167	99.09%	225	98.95%
250	99.16%	300	99.02%
333	99.23%	500	99.09%
—	—	750	99.16%
—	—	1000	99.23%

a. Efficiencies are based on procedures in the Code of Federal Regulations 10 CFR 431, Subpart K, Appendix A, "Uniform Test Method for Measuring the Energy Consumption of Distribution Transformers."

TABLE B-1 (Supersedes Table 6.8.1-1 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary Air Conditioners and Condensing Units (SI)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air cooled	<19 kW (one phase)	All	Split systems	4.10 $SCOP_C$ 3.52 COP_C	AHRI 210/240
			Single packaged	4.10 $SCOP_C$ 3.40 COP_C	
	<19 kW (three phase)	All	Split systems	4.10 $SCOP_C$ 3.52 COP_C	
			Single packaged	4.10 $SCOP_C$ 3.40 COP_C	
Through the wall, air cooled	<9 kW	All	Split systems	3.52 $SCOP_C$	
			Single packaged	3.52 $SCOP_C$	
Small duct high velocity, air cooled	<19 kW (one phase)	All	Split systems	3.22 $SCOP_C$ before 1/1/2015 3.52 $SCOP_C$ after 1/1/2015	
	<19 kW (three phase)	All	Split systems	3.22 $SCOP_C$	
Air conditioners air cooled	≥19 kW and <40 kW	Electric resistance (or none)	Split systems and single packaged	3.43 COP_C 3.81 $ICOP_C$	ARI 340/360
		All other	Split systems and single packaged	3.31 COP_C 3.75 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	Split systems and single packaged	3.43 COP_C 3.66 $ICOP_C$	
		All other	Split systems and single packaged	3.37 COP_C 3.60 $ICOP_C$	
	≥70 kW and <223 kW	Electric resistance (or none)	Split systems and single packaged	3.08 COP_C 3.31 $ICOP_C$	
		All other	Split systems and single packaged	3.02 COP_C 3.25 $ICOP_C$	
	≥223 kW	Electric resistance (or none)	Split systems and single packaged	2.90 COP_C 3.25 $ICOP_C$	
		All other	Split systems and single packaged	2.84 COP_C 3.19 $ICOP_C$	
Air conditioners, water cooled	<19 kW	All	Split systems and single packaged	4.10 COP_C 4.19 $ICOP_C$	AHRI 210/240
	≥19 kW and <140 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.48 $ICOP_C$	AHRI 340/360
		All other	Split systems and single packaged	4.04 COP_C 4.43 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	
	≥70 kW and <223 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	
	≥223 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-1 (Supersedes Table 6.8.1-1 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary Air Conditioners and Condensing Units (SI) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, evaporatively cooled	<19 kW	All	Split systems and single packaged	4.10 COP_C	AHRI 210/240
				4.19 $ICOP_C$	AHRI 340/360
	≥19 kW and <140 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.48 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.43 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	
	≥70 kW and <223 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	
	≥223 kW	Electric resistance (or none)	Split systems and single packaged	4.10 COP_C 4.34 $ICOP_C$	
		All other	Split systems and single packaged	4.04 COP_C 4.28 $ICOP_C$	
Condensing units, air cooled	≥40 kW			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	≥40 kW			Not applicable match with indoor coil	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-2 (Supersedes Table 6.8.1-2 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary and Applied Heat Pumps Minimum Efficiency Requirements (SI)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air cooled (cooling mode)	<19 kW (one phase)	All	Split systems	4.10 $SCOP_C$ 3.52 COP_C	AHRI 210/240
			Single packaged	4.10 $SCOP_C$ 4.00 COP_C	
	<19 kW (three phase)	All	Split systems	4.10 $SCOP_C$ 3.52 COP_C	
			Single packaged	4.10 $SCOP_C$ 3.40 COP_C	
Through the wall, air cooled (cooling mode)	<9 kW	All	Split systems	3.52 $SCOP_C$	
			Single packaged	3.52 $SCOP_C$	
Small duct high velocity, air cooled (cooling mode)	<19 kW (one phase)	All	Split systems	3.22 $SCOP_C$ before 1/1/2015 3.52 $SCOP_C$ after 1/1/2015	
	<19 kW (three phase)	All	Split systems	3.22 $SCOP_C$	
Air conditioners, air cooled (cooling mode)	≥19 kW and <40 kW	Electric resistance (or none)	Split systems and single packaged	3.31 COP_C 3.60 $ICOP_C$	AHRI 340/360
		All other	Split systems and single packaged	3.25 COP_C 3.55 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	Split systems and single packaged	3.19 COP_C 3.49 $ICOP_C$	
		All other	Split systems and single packaged	3.14 COP_C 3.43 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	Split systems and single packaged	3.02 COP_C 3.19 $ICOP_C$	
		All other	Split systems and single packaged	2.96 COP_C 3.14 $ICOP_C$	
Water to air water loop (cooling mode)	<5 kW	All	30°C entering water	4.10 COP_C	ISO-13256-1
	≥5 kW and <19kW	All	30°C entering water	4.10 COP_C	
	>19kW and <40 kW	All	30°C entering water	4.10 COP_C	
Water to air ground water (cooling mode)	<40 kW	All	15°C entering water	5.28 COP_C	
Water to air ground loop (cooling mode)	<40 kW	All	25°C entering water	4.13 COP_C	
Water to water water loop (cooling mode)	<40 kW	All	30°C entering water	3.11 COP_C	ISO-13256-2
Water to water groundwater (cooling mode)	<40 kW	All	15°C entering water	4.78 COP_C	
Brine to water ground loop cooing mode)	<40 kW	All	30° C entering water	3.52 COP_C	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-2 (Supersedes Table 6.8.1-2 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Unitary and Applied Heat Pumps Minimum Efficiency Requirements (SI) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Conditions	Minimum Efficiency	Test Procedure[a]
Air conditioners, air cooled (heating mode)	<19kW (cooling capacity) (one phase)	All	Split systems	2.64 COP_H	AHRI 210/240
			Single packaged	2.49 COP_H	
Air conditioners, air cooled (heating mode)	<19kW (cooling capacity) (three phase)	All	Split systems	2.64 COP_H	
			Single packaged	2.49 COP_H	
Through the wall, air cooled (heating mode)	<9 kW (cooling capacity)	All	Split systems	2.17 COP_H	
			Single packaged	2.17 COP_H	
Small duct high velocity, air cooled (heating mode)	<19kW (cooling capacity) (one phase)	All	Split systems	1.99 COP_H before 1/1/2015 2.11 COP_H after 1/1/2015	
	<19kW (cooling capacity) (three phase)	All	Split systems	1.99 COP_H	
Air cooled (heating mode)	≥19kW and <40 kW (cooling capacity)		8.3°C DB/6.1°C wb *outdoor air*	3.3 COP_H	AHRI 340/360
			–8.3°C DB/9.415°C wb *outdoor air*	2.25 COP_H	
	≥40 kW (cooling capacity)		8.3°C DB/6.1°C wb *outdoor air*	3.2 COP_H	
			–8.3°C DB/9.415°C wb *outdoor air*	2.05 COP_H	
Water to air water loop (heating mode)	<40 kW (cooling capacity)		20°C entering water	4.3COP_H	ISO-1356-1
Water to air groundwater (heating mode)	<40 kW (cooling capacity)		10°C entering water	3.7 COP_H	
Brine to air ground loop (heating mode)	<40 kW (cooling capacity)		0°C entering fluid	3.2 COP_H	
Water to water water loop (heating mode)	<40 kW (cooling capacity)		20°C entering water	3.7 COP_H	ISO-13256-2
Water to water groundwater (heating mode)	<40 kW (cooling capacity)		10°C entering water	3.1 COP_H	
Brine to water ground loop (heating mode)	<40 kW (cooling capacity)		0°C entering fluid	2.5 COP_H	

a. Section 11 contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B-3 (Supersedes Table 6.8.1-3 in ANSI/ASHRAE/IES Standard 90.1-2013)
Water-Chilling Packages—Efficiency Requirements (SI)[a,b,e]

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure[c]
Air cooled chillers	<528 kW	COP (W/W)	≥2.985FL	≥2.866 FL	AHRI 551/591
			≥4.048 IPLV	≥4.669 IPLV	
	≥528 kW		≥2.985 FL	≥2.866 FL	
			≥4.137 IPLV	≥4.758 IPLV	
Air cooled without condenser, electrically operated	All capacities	COP (W/W)	Condenserless units shall comply with air-cooled chiller requirements with a matched condenser.		
Water cooled, electrically operated positive displacement	<264 kW	COP (W/W)	≥4.694 FL	≥4.513 FL	
			≥5.867 IPLV	≥7.041 IPLV	
	≥264 kW and <528 kW		≥4.889 FL	≥4.694 FL	
			≥6.286 IPLV	≥7.184 IPLV	
	≥528 kW and <1055 kW		≥5.334 FL	≥5.177 FL	
			≥6.519 IPLV	≥8.001 IPLV	
	≥1055kW and <2110 kW		≥5.771 FL	≥5.633 FL	
			≥6.770 IPLV	≥8.586IPLV	
	≥2100 kW		≥6.286 FL	≥6.018 FL	
			≥7.041 IPLV	≥9.264 IPLV	
Water cooled, electrically operated centrifugal[f]	<528 kW	COP (W/W)	≥5.771 FL	≥5.065 FL	
			≥6.401 IPLV	≥8.001 IPLV	
	≥528 kW and <1055 kW		≥5.771 FL	≥5.544 FL	
			≥6.401 IPLV	≥8.801 IPLV	
	≥1055 kW and <1407kW		≥6.286 FL	≥5.917 FL	
			≥6.770 IPLV	≥9.027 IPLV	
	≥1407 kW and <2110 kW		≥6.286 FL	≥6.018 FL	
			≥7.041 IPLV	≥9.264 IPLV	
	≥2110 kW		≥6.286 FL	≥6.018 FL	
			≥7.041 IPLV	≥9.264 IPLV	

a. The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed in AHRI 551/591. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

c. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

d. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

e. FL is the full-load performance requirements, and IPLV is for the part-load performance requirements.

f. Centrifugal chillers not designed for operation at AHRI Standard 551/591 test conditions of 7.0°C leaving and 12.0 C° entering chilled-fluid temperatures, and with 30.0°C entering and 35.0°C leaving condenser-fluid temperatures (and thus cannot be tested to meet the requirements of Table B-3) shall have maximum full-load (FL) COP and NPLV part-load ratings requirements adjusted using the following equations:

$$FL_{adj} = FL/K_{adj}$$

$$PLV_{adj} = IPLV/K_{adj}$$

$$K_{adj} = A \times B$$

where

FL = full-load COP value from Table B-3

FL_{adj} = minimum full-load COP rating, adjusted for nonstandard conditions

IPLV = IPLV value from Table B-3

PLV_{adj} = minimum NPLV rating, adjusted for nonstandard conditions

A = $0.0000015318 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times (LIFT) + 3.930196$

B = $0.0027 \times LvgEvap + 0.982$

LIFT = LvgCond – LvgEvap

LvgCond = full-load condenser leaving fluid temperature, °C

LvgEvap = full-load evaporator leaving temperature, °C

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum evaporator leaving temperature: 2.0°C
- Maximum condenser leaving temperature: 46°C
- 11.0°C ≤ LIFT ≤ 44.0°C

TABLE B-3 (Supersedes Table 6.8.1-3 in ANSI/ASHRAE/IES Standard 90.1-2013)
Water-Chilling Packages—Efficiency Requirements (SI)[a,b,e] *(Continued)*

Equipment Type	Size Category	Units	Path A	Path B	Test Procedure[c]
Air-cooled absorption, single effect	All capacities	COP (W/W)	≥0.600 FL	NA[d]	AHRI 560
Water-cooled absorption, single effect	All capacities	COP (W/W)	≥0.700 FL	NA[d]	
Absorption double effect, indirect fired	All capacities	COP (W/W)	≥1.000 FL	NA[d]	
			≥1.050 IPLV		
Absorption double effect, direct fired	All capacities	COP (W/W)	≥1.000 FL	NA[d]	
			≥1.000 IPLV		

a. The requirements for centrifugal chillers shall be adjusted for nonstandard rating conditions per Section 6.4.1.2.1 and are only applicable for the range of conditions listed in AHRI 551/591. The requirements for air-cooled, water-cooled positive displacement and absorption chillers are at standard rating conditions defined in the reference test procedure.

b. Both the full load and IPLV requirements must be met or exceeded to comply with this standard. When there is a Path B, compliance can be with either Path A or Path B for any application.

c. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

d. NA means the requirements are not applicable for Path B and only Path A can be used for compliance.

e. FL is the full-load performance requirements, and IPLV is for the part-load performance requirements.

f. Centrifugal chillers not designed for operation at AHRI Standard 551/591 test conditions of 7.0°C leaving and 12.0 C° entering chilled-fluid temperatures, and with 30.0°C entering and 35.0°C leaving condenser-fluid temperatures (and thus cannot be tested to meet the requirements of Table B-3) shall have maximum full-load (FL) COP and NPLV part-load ratings requirements adjusted using the following equations:

$$FL_{adj} = FL/K_{adj}$$

$$PLV_{adj} = IPLV/K_{adj}$$

$$K_{adj} = A \times B$$

where

FL = full-load COP value from Table B-3

FL_{adj} = minimum full-load COP rating, adjusted for nonstandard conditions

IPLV = IPLV value from Table B-3

PLV_{adj} = minimum NPLV rating, adjusted for nonstandard conditions

A = $0.0000015318 \times (LIFT)^4 - 0.000202076 \times (LIFT)^3 + 0.0101800 \times (LIFT)^2 - 0.264958 \times (LIFT) + 3.930196$

B = $0.0027 \times LvgEvap + 0.982$

LIFT = LvgCond – LvgEvap

LvgCond = full-load condenser leaving fluid temperature, °C

LvgEvap = full-load evaporator leaving temperature, °C

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- Minimum evaporator leaving temperature: 2.0°C
- Maximum condenser leaving temperature: 46°C
- 11.0°C ≤ LIFT ≤ 44.0°C

TABLE B-4 (Supersedes Table 6.8.1-4 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single Packaged Vertical Air Conditioners, Single Packaged Vertical Heat Pumps, Room Air Conditioners and Room Air Conditioners Heat Pumps—Minimum Efficiency Requirements (SI)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
PTAC (cooling mode) new construction	<2.0 kW	35°C db *outdoor air*	3.49 COP_C	ARI 310/380
	≥2.0 kW and <2.9 kW	35°C db *outdoor air*	3.31 COP_C	
	≥2.9 kW and <3.8 kW	35°C db *outdoor air*	3.14 COP_C	
	≥ 3.8 kW	35°C db *outdoor air*	3.48 COP_C	
PTAC (cooling mode) replacement[b]	<2.0 kW	35°C db *outdoor air*	3.49 COP_C	ARI 310/380
	≥2.0 kW and <2.9 kW	35°C db *outdoor air*	3.31 COP_C	
	≥2.9 kW and <3.8 kW	35°C db *outdoor air*	3.14 COP_C	
	≥ 3.8 kW	35°C db *outdoor air*	3.48 COP_C	
PTHP (cooling mode) new construction	<2.0 kW	35°C db *outdoor air*	3.48 COP_C	ARI 310/380
	≥2.0 kW and <2.9 kW	35°C db *outdoor air*	3.48 COP_C	
	≥2.9 kW and <3.8 kW	35°C db *outdoor air*	3.48 COP_C	
	≥3.8 kW	35°C db *outdoor air*	3.48 COP_C	
PTHP (heating mode) new construction	All capacities	35°C db *outdoor air*	2.8 COP_H	ARI 310/380
PTHP (cooling mode) replacement[b]	<2.0 kW	35°C db *outdoor air*	3.43 COP_C	ARI 310/380
	≥2.0 kW and <2.9 kW	35°C db *outdoor air*	3.25 COP_C	
	≥2.9 kW and <3.8 kW	35°C db *outdoor air*	3.08 COP_C	
	≥3.8 kW	35°C db *outdoor air*	2.73 COP_C	
PTHP (heating mode) replacement[b]	All capacities	35°C db *outdoor air*	2.8 COP_H	ARI 310/380

a. Section 11 contains a complete specification of the referenced test procedures, including year version of the test procedure.

b. Replacement units shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 in. high and less than 42 in. wide.

TABLE B-5 (Supersedes Table 6.8.1-4 in ANSI/ASHRAE/IES Standard 90.1)
Single Packaged Vertical Air Conditioners, Single Packaged Vertical Heat Pumps, Room Air Conditioners, and Room Air-Conditioner Heat Pumps—Minimum Efficiency Requirements (SI)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
SPVAC (cooling mode)	<19 kW	35°C db/23.9°C wb *outdoor air*	4.10 $SCOP_C$	AHRI 390
	≥19 kW and <40 kW	35°C db/23.9°C wb *outdoor air*	3.28 COP_C 3.78 $ICOP_C$	
	≥40 kW and <70 kW	35°C db/23.9°C wb *outdoor air*	3.22 COP_C 3.63 $ICOP_C$	
SPVHP (cooling mode)	<19 kW	35°C db/23.9°C wb *outdoor air*	4.10 $SCOP_C$	
	≥19 kW and <40 kW	35°C db/23.9°C wb *outdoor air*	3.22 COP_C 3.58 $ICOP_C$	
	≥40 kW and <70 kW	35°C db/23.9°C wb *outdoor air*	3.11 COP_C 3.40 $ICOP_C$	
SPVHP (heating mode)	<19 kW	8.3°C db/6.1°C wb *outdoor air*	2.34 $SCOP_H$	
	≥19 kW and <40 kW	8.3°C db/6.1°C wb *outdoor air*	3.30 COP_H	
	≥40 kW and <70 kW	8.3°C db/6.1°C wb *outdoor air*	2.9 COP_H	
Room air conditioners with louvered sides	<1.8 kW		3.14 COP_C	ANSI/AHAM RAC-1
	≥1.8 kW and <2.3 kW		3.14 COP_C	
	≥2.3 kW and <4.1 kW		3.17 COP_C	
	≥4.1 kW and <5.9 kW		3.14 COP_C	
	≥5.9 kW		2.75 COP_C	
Room air conditioners without louvered sides	<2.3 kW		2.90 COP_C	
	≥2.3 kW and <5.9 kW		2.75 COP_C	
	≥5.9 kW		2.73 COP_C	
Room air conditioner heat pump with louvered sides	<5.9 kW		2.90 COP_C	
	≥5.9 kW		2.73 COP_C	
Room air conditioner heat pump without louvered sides	<4.1 kW		2.75 COP_C	
	≥4.1 kW		2.58 COP_C	
Room air conditioner, casement only	All capacities		2.81 COP_C	
Room air conditioner, casement slider	All capacities		3.08 COP_C	

a. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.

TABLE B-6 (Supersedes Table 6.8.1-5 in ANSI/ASHRAE/IES Standard 90.1)
Warm-Air Furnace and Combustion Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces and Unit Heaters (SI)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Test Procedure[b]	Minimum Efficiency[a]
Warm air furnace, gas fired (weatherized)	<65.9 kW	Maximum capacity[d]	DOE 10 CFR Part 430 or ANSI Z21.47	78% AFUE or 80% E_t[c,e]
	>65.9 kW	Maximum capacity[d]	ANSI Z21.47	80% E_c[c,e]
Warm air furnace, gas fired (nonweatherized)	<65.9 kW	Maximum capacity[d]	DOE 10 CFR Part 430 or ANSI Z21.47	90% AFUE or 92% E_t[c,e]
	>65.9 kW	Maximum capacity[d]	ANSI Z21.47	92% E_c[c,e]
Warm air furnace, oil fired (weatherized)	<65.9 kW	Maximum capacity[d]	DOE 10 CFR Part 430 or UL 727	78% AFUE or 80% E_t[c,e]
	>65.9 kW	Maximum capacity[d]	UL 727	81% E_t[e]
Warm air furnace, oil fired (nonweatherized)	<65.9 kW	Maximum capacity[d]	DOE 10 CFR Part 430 or UL 727	85% AFUE or 87%% E_t[c,e]
	>65.9 kW	Maximum capacity[d]	UL 727	87% E_t[e]
Warm air duct furnaces, gas fired (weatherized)	All capacities	Maximum capacity[d]	ANSI Z83.9	80% E_c[f]
Warm air duct furnaces, gas fired (nonweatherized)	All capacities	Maximum capacity[d]	ANSI Z83.9	90% E_c[f]
Warm air unit heaters, gas fired (nonweatherized)	All capacities	Maximum capacity[d]	ANSI Z83.8	90% E_c[f,g]
Warm air unit heaters, oil fired (nonweatherized)	All capacities	Maximum capacity[d]	UL 731	90% E_c[f,g]

a. E_t = thermal efficiency. See test procedure for detailed discussions.

b. Section 11 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

c. Combustion units not covered by NAECA (three-phase power or cooling capacity greater than or equal to 19.0 kW) may comply with either rating.

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

e. Units shall also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or flue damper. A vent damper is an acceptable alternative to the fuel damper for those furnaces where combustion air is drawn from the *conditioned space*.

f. E_c = combustion efficiency (100% less flue losses). See test procedures for detailed discussion.

g. As of August 8, 2008, according to the Energy Policy Act of 2005, units shall also include an interrupted or intermittent ignition devices (IID) and have either power venting or *automatic* flue dampers. A vent damper is an acceptable alternative to a flue damper for those unit heaters where combustion air is drawn from the *conditioned space*.

TABLE B-7 (Supersedes Table 6.8.1-6 in ANSI/ASHRAE/IES Standard 90.1)
Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements (SI)

Equipment Type[a]	Subcategory or Rating Condition	Size Category (Input)	Efficiency[b,c]	Test Procedure[g]
Boilers, hot water	Gas fired	<87.9 kW[h,i]	89% AFUE[f]	10 CFR Part 430
		≥87.9 kW and <732.7 kW[d]	89% E_t[f]	10 CFR Part 431
		≥732.7 kW[a]	91% E_c[f]	
	Oil fired[e]	<87.9 kW	89% AFUE[f]	10 CFR Part 430
		≥87.9 kW and <732.7 kW[d]	85% E_t[f]	10 CFR Part 431
		≥732.7 kW[a]	86% E_c[f]	
Boilers, steam	Gas fired	<87.9 kW[i]	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥87.9 kW and <732.7 kW[d]	79% E_t	10 CFR Part 431
		≥732.7 kW[a]	79% E_t	
	Gas fired natural draft	≥87.9 kW and <732.7 kW[d]	77% E_t	
		≥732.7 kW[a]	77% E_t	
	Oil fired[e]	<87.9 kW	82% AFUE	10 CFR Part 430
		≥87.9 kW and <732.7 kW[d]	81% E_t	10 CFR Part 431
		≥732.7 kW[a]	81% E_t	

a. These requirements apply to boilers with rated input of 2344 kW or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
c. E_t = thermal efficiency. See reference document for detailed information.
d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
e. Includes oil fired (residual).
f. Systems shall be designed with lower operating return hot-water temperatures (<55°C) and use hot-water reset to take advantage of the higher efficiencies of condensing boilers.
g. Section 11 contains details for the referenced test procedure, including the referenced year version of the test procedure.
h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
i. Boilers shall not be equipped with a continuous pilot ignition system.

TABLE B-8 (Supersedes Table 6.8.1-7 in ANSI/ASHRAE/IES Standard 90.1)
Performance Requirements for Heat-Rejection Equipment (SI)

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition[g]	Performance Required [a,b,c,d,e,f,i]	Test Procedure[h]
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥3.40 L/s kW	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥1.86 L/s kW	CTI ATC-105 and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥1.27 L/s kW	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	≥0.68 L/s kW	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥52.6 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	≥43.2 COP	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	≥61.7 COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	≥53.1 COP	CTI ATC-106
Air-cooled condensers	All	88°C entering gas temperature 52°C condensing temperature 8°C subcooling 35°C entering wb	≥69 COP	AHRI 460

a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B-8 divided by the fan motor nameplate power.

b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B-8 divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.

c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.

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

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

f. All cooling towers, closed-circuit coolers, evaporative condensers and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.

g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.

h. Informative Appendix G contains information on the referenced test procedures.

i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in Table B-3.

TABLE B-9 (Supersedes Table 7.8 in ANSI/ASHRAE/IES Standard 90.1)
Performance Requirements for Water Heating Equipment (SI)

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Performance Required [a]	Test Procedure [b]
Electric table-top water heaters[e]	≤12 kW	Resistance > 75.7L	EF ≥ 0.93 – 0.00035V	DOE 10 CFR Part 430
Electric water heaters[e]	12 kW	Resistance > 75.7L	EF ≥ 0.97 – 0.00035V	DOE 10 CFR Part 430
	>12 kW	Resistance > 75.7L	SL ≤ 0.3 + 4.07 $\sqrt{V}$, W	ANSI Z21.10.3
	All	Heat pump	EF ≥ 2.0	DOE 10 CFR Part 430
Gas storage water heaters[f]	<22.98 kW	Resistance > 75.7L	E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/800 + 16.6$\sqrt{V}$), W	DOE 10 CFR Part 430
	>22.98 kW	<309.75 W/L	E_t ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 × (Q/800 + 16.6 $\sqrt{V}$), W	ANSI Z21.10.3
Gas instantaneous water heaters[d]	>14.66 kW and <58.62 kW	>309.75 W/L and <7 L	E_t ≥ 0.94 or EF ≥ 0.93	DOE 10 CFR Part 430
	>58.62 kW[c]	>309.75 W/L and <37.5 L	E_t ≥ 0.94 or EF ≥ 0.93	ANSI Z21.10.3
	>58.62 kW	>309.75 W/L and <37.5 L	E_t ≥ 0.94 or EF ≥ 0.93	
Oil storage water heaters	<30.78 kW	Resistance >75.7L	EF ≥ 0.59 – 0.00031V	DOE 10 CFR Part 430
	>30.78 kW	<309.75 W/L	E_t ≥ 80% and SL ≤ (Q/799 + 2.5 $\sqrt{V}$), W	ANSI Z21.10.3
Oil instantaneous water heaters	<61.55 kW	≥309.75 W/L and <7.56 L	EF ≥ 0.59 – 0.00031V	DOE 10 CFR Part 430
	>61.55 kW	≥309.75 W/L and <37.5 L	E_t ≥ 80%	ANSI Z21.10.3
	>61.55 kW	≥309.75 W/L and ≥37.5 L	E_t ≥ 78% and SL ≤ (Q/799 + 2.5 $\sqrt{V}$), W	
Hot-water supply boilers, gas and oil	61.55 kW and <3663.8 kW	≥309.75 W/L and <37.5 L	E_t ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥309.75 W/L and ≥37.5 L	E_t ≥ 80% and SL ≤ (Q/799 + 2.5 $\sqrt{V}$), W	
Hot-water supply boilers, oil		≥309.75 W/L and ≥37.5 L	E_t ≥ 78% and SL ≤ (Q/799 + 2.5 $\sqrt{V}$), W	
Pool heaters, oil and gas	All		E_t ≥ 78%	ASHRAE 146
Heat pump pool heaters	All		≥4.0 COP	ASHRAE 146
Unfired storage tanks	All		≥R-2.2, °C·m^2/W	(none)

a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements, while standby loss (SL) is maximum W based on a 39°C temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in litres. In the SL equation, V is the rated volume in litres and Q is the nameplate input rating in watts.

b. Section 11 contains a complete specification, including the year version, of the referenced test procedure.

c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency" and Section G.2 is titled "Test Method for Measuring Standby Loss."

d. Instantaneous water heaters with input rates below 58.5 kW must comply with these requirements if the water heater is designed to heat water to temperatures of 82°C or higher.

e. Electric water heaters with input rates below 12 kW must comply with these requirements if the water heater is designed to heat water to temperatures of 82°C or higher.

f. Refer to ANSI/ASHRAE/IES Standard 90.1 Section 7.5.3 for additional requirements for gas storage and instantaneous water heaters and gas hot-water supply boilers.

TABLE B-10 Commercial Refrigerator and Freezers (SI)

Equipment Type	Application	Energy Use Limit (kW/h per day)[a]
Refrigerators with solid doors	Holding temperature	$2.831V + 57.75$
Refrigerators with transparent doors		$3.40V + 94.55$
Freezers with solid doors		$11.32V + 39.07$
Freezers with transparent doors		$21.23V + 116.07$
Refrigerators/freezers with solid doors		Greater of $3.40V + 94.55$ or 19.82
Commercial Refrigerators	Pulldown	$1.26V + 99.37$

a. V is the chiller or frozen compartment volume (litres) as defined in the Association of Home Appliance Manufacturers Standard HRF1-1979.

TABLE B-11 Commercial Clothes Washers (SI)

Product	MEF[a]	WF[b], L/L
All commercial clothes washers	48.7	0.53

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many liters of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency.

b. *WF = water factor* (in L/L).

TABLE B-12 (Supersedes Table 6.8.1-9 in ANSI/ASHRAE/IES Standard 90.1) Electrically Operated Variable-Refrigerant-Flow (VRF) Air Conditioners Minimum Efficiency (SI)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air conditioners, air cooled	<19 kW	All	VRF multisplit system	4.10 $SCOP_C$ 3.52 COP_C	AHRI 1230
	≥19 kW and <40 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP_C 4.37 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP_C 4.22 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system	3.08 COP_C 3.81 $ICOP_C$	

a. Section 11 contains details for the referenced test procedure, including year version of the test procedure.

TABLE B-13 (Supersedes Table 6.8.1-10 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Variable-Refrigerant-Flow (VRF) Heat-Pump Air Conditioners Minimum Efficiency (SI)

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air cooled (cooling mode)	<19 kW	All	VRF multisplit system	4.10 $SCOP_C$ 3.52 COP_C	AHRI 1230
	≥19 kW and <40 kW	Electric resistance (or none)	VRF multisplit system	3.31 COP_C 4.16 $ICOP_C$	
	≥19 kW and <40 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.25 COP_C 4.10 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	VRF multisplit system	3.19 COP_C 4.02 $ICOP_C$	
	≥40 kW and <70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.14 COP_C 3.96 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system	3.02 COP_C 3.66 $ICOP_C$	
	≥70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	2.96 COP_C 3.60 $ICOP_C$	
VRF water source (cooling mode)	<19 kW	All	VRF multisplit systems 30°C entering water	4.10 COP_C	AHRI 1230
	<19 kW	All	VRF multisplit systems with heat recovery 30°C entering water	4.04 COP_C	
	≥19 kW and <40 kW	All	VRF multisplit system 30°C entering water	4.10 COP_C	
	≥19 kW and <40 kW	All	VRF multisplit system with heat recovery 30°C entering water	4.04 COP_C	
	≥40 kW	All	VRF multisplit system 30°C entering water	3.40 COP_C	
	≥40 kW	All	VRF multisplit system with heat recovery 30°C entering water	3.28 COP_C	
VRF groundwater source (cooling mode)	<40 kW	All	VRF multisplit system 15°C entering water	4.75 COP_C	AHRI 1230
	<40 kW	All	VRF multisplit system with heat recovery 15°C entering water	4.69 COP_C	
	≥40 kW	All	VRF multisplit system 15°C entering water	4.04 COP_C	
	≥40 kW	All	VRF multisplit system with heat recovery 15°C entering	3.99 COP_C	
VRF ground source (cooling mode)	<40 kW	All	VRF multisplit system 25°C entering water	3.93 COP_C	AHRI 1230
	<40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.87 COP_C	
	≥40 kW	All	VRF multisplit system 25°C entering water	3.22 COP_C	
	≥40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.17 COP_C	

a. Section 11 contains a complete specification of the reference test procedure, including year version of the test procedure.

TABLE B-13 (Supersedes Table 6.8.1-10 in ANSI/ASHRAE/IES Standard 90.1)
Electrically Operated Variable-Refrigerant-Flow (VRF) Heat-Pump Air Conditioners Minimum Efficiency (SI) *(Continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF air cooled (heating mode)	<19 kW (cooling capacity)	—	VRF multisplit system	2.49 $SCOP_H$	AHRI 1230
	≥19 kW and <40 kW (cooling capacity)	—	VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.40 COP_H	
		—	–8.3°C db/–9.4°C wb *outdoor air*	2.40 COP_H	
	≥40 kW (cooling capacity)	—	VRF multisplit system 8.3°C db/6.1°C wb *outdoor air*	3.20 COP_H	
		—	–8.3°C db/–9.4°C wb *outdoor air*	2.10 COP_H	
VRF water source (heating mode)	<40 kW (cooling capacity)	—	VRF multisplit system 20°C entering water	4.60 COP_H	AHRI 1230
	≥40 kW (cooling capacity)	—	VRF multisplit system 20°C entering water	4.20 COP_H	
VRF groundwater source (heating mode)	<40 kW (cooling capacity)	—	VRF multisplit system 10°C entering water	3.60 COP_H	AHRI 1230
	≥40 kW (cooling capacity)	—	VRF multisplit system 10°C entering water	3.30 COP_H	
VRF ground source (heating mode)	<40 kW (cooling capacity)	—	VRF multisplit system 0°C entering fluid	3.10 COP_H	AHRI 1230
	≥40 kW (cooling capacity)	—	VRF multisplit system 0°C entering fluid	2.80 COP_H	

a. Section 11 contains a complete specification of the reference test procedure, including year version of the test procedure.

TABLE B-14 Commercial Refrigeration Minimum Efficiency Requirements (SI Units)

Equipment Type					
Equipment Class[a]	**Family Code**	**Operating Mode**	**Rating Temperature**	**Energy Use Limits, kWh/day, as of 1/1/2012[b,c]**	**Test Procedure**
VOP.RC.M	Vertical open	Remote condensing	Medium temperature	8.83 × TDA + 4.07[d]	
SVO.RC.M	Semivertical open	Remote condensing	Medium temperature	8.93 × TDA + 3.18[d]	
HZO.RC.M	Horizontal open	Remote condensing	Medium temperature	3.77 × TDA + 2.88[d]	
VOP.RC.L	Vertical open	Remote condensing	Low temperature	24.43 × TDA +6.85[d]	
HZO.RC.L	Horizontal open	Remote condensing	Low temperature	6.14 × TDA + 6.88[d]	
VCT.RC.M	Vertical transparent door	Remote condensing	Medium temperature	2.37 × TDA + 1.95	
VCT.RC.L	Vertical transparent door	Remote condensing	Low temperature	6.03 × TDA + 2.61	
SOC.RC.M	Service over counter	Remote condensing	Medium temperature	5.49 × TDA + 0.11	
VOP.SC.M	Vertical open	Self contained	Medium temperature	18.73 × TDA + 4.71[d]	
SVO.SC.M	Semivertical open	Self contained	Medium temperature	18.62 × TDA + 4.59[d]	
HZO.SC.M	Horizontal open	Self contained	Medium temperature	8.29 × TDA + 5.55[d]	
HZO.SC.L	Horizontal open	Self contained	Low temperature	20.67 × TDA + 7.08[d]	
VCT.SC.I	Vertical transparent door	Self contained	Ice cream	7.21 × TDA + 3.29	
VCS.SC.I	Vertical solid door	Self contained	Ice cream	13.42 × V + 0.88	
HCT.SC.I	Horizontal transparent door	Self contained	Ice cream	6.03 × TDA + 0.43	
SVO.RC.L	Semivertical open	Remote condensing	Low temperature	24.43 × TDA + 6.85[d]	AHRI 1200
VOP.RC.I	Vertical open	Remote condensing	Ice cream	31.10 × TDA + 8.7[d]	
SVO.RC.I	Semivertical open	Remote condensing	Ice cream	31.11 × TDA + 8.7 [d]	
HZO.RC.I	Horizontal open	Remote condensing	Ice cream	7.75 × TDA + 8.74[d]	
VCT.RC.I	Vertical transparent door	Remote condensing	Ice cream	7.10 × TDA + 3.05	
HCT.RC.M	Horizontal transparent door	Remote condensing	Medium temperature	1.72 × TDA + 0.13	
HCT.RC.L	Horizontal transparent door	Remote condensing	Low temperature	3.66 × TDA + 0.26	
HCT.RC.I	Horizontal transparent door	Remote condensing	Ice cream	4.31 × TDA + 0.31	
VCS.RC.M	Vertical solid door	Remote condensing	Medium temperature	3.88 × V + 0.26	
VCS.RC.L	Vertical solid door	Remote condensing	Low temperature	8.12 × V + 0.54	
VCS.RC.I	Vertical solid door	Remote condensing	Ice cream	9.53 × V + 0.63	
HCS.RC.M	Horizontal solid door	Remote condensing	Medium temperature	3.88 × V + 0.26	
HCS.RC.L	Horizontal solid door	Remote condensing	Low temperature	8.12 × V + 0.54	
HCS.RC.I	Horizontal solid door	Remote condensing	Ice cream	9.53 × V + 0.63	
SOC.RC.L	Service over counter	Remote condensing	Low temperature	11.63 × TDA + 0.22	
SOC.RC.I	Service over counter	Remote condensing	Ice cream	13.56 × TDA + 0.26	
VOP.SC.L	Vertical open	Self contained	Low temperature	4.37 × TDA + 11.82[d]	
VOP.SC.I	Vertical open	Self contained	Ice cream	5.55 × TDA + 15.02[d]	
SVO.SC.L	Semivertical open	Self contained	Low temperature	4.34 × TDA + 11.51[d]	
SVO.SC.I	Semivertical open	Self contained	Ice cream	5.52 × TDA + 14.63 [d]	AHRI 1200
HZO.SC.I	Horizontal open	Self contained	Ice cream	2.44 × TDA + 9.0 [d]	
SOC.SC.I	Service over counter	Self contained	Ice cream	18.94 × TDA + 0.36	
HCS.SC.I	Horizontal solid door	Self contained	Ice cream	13.42 × V + 0.88	

a. Equipment class designations consist of a combination (in sequential order separated by periods (AAA).(BB).(C) of the following:

(AAA) An equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical transparent doors, VCS = vertical solid doors, HCT = horizontal transparent doors, HCS = horizontal solid doors, or SOC = service over counter)

(BB) An operating mode code (RC = remote condensing or SC = self contained)

(CC) A rating temperature code (M = medium temperature [3°C], L = low temperature [–18°C], or I = ice-cream temperature [–9°C])

For example, "VOP.RC.M" refers to the "vertical open, remote condensing, medium temperature" equipment class.

b. V (m^3) is the volume of the case, as measured in AHRI Standard 1200, Appendix C.

c. TDA (m^2) is the total display area of the case, as measured in AHRI Standard 1200, Appendix D.

d. Open refrigerated display cases shall be covered by field-installed strips, curtains, or doors.

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX C
PERFORMANCE OPTION FOR ENERGY EFFICIENCY

C1. GENERAL

C1.1 Performance Option Scope. *Building projects* complying with Section 7.5, the "Performance Option," shall comply with the requirements in Normative Appendix G of ANSI/ASHRAE/IES Standard 90.1 with the following modifications and additions. When a requirement is provided in this appendix, it supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1. This appendix shall be used both for *building projects* demonstrating compliance with the requirements of this standard and for *building projects* demonstrating performance that substantially exceeds the requirements of this standard. Where stated in Normative Appendix G of ANSI/ASHRAE/IES Standard 90.1, the rating authority or program evaluator shall be the *authority having jurisdiction* (*AHJ*).

Note to Adopting Authority: ASHRAE Standing Standard Project Committee 189.1 recommends that a compliance shell implementing the rules of a compliance supplement that controls inputs to and reports outputs from the required computer analysis program be adopted for the purposes of easier use and simpler compliance.

C1.1.1 Performance Rating Mandatory Requirements (Section G1.2 of ANSI/ASHRAE/IES Standard 90.1). In addition to the requirements in Section G1.2 of ANSI/ASHRAE/IES Standard 90.1, all requirements in Sections 5.3, 6.3, 7.3, 8.3, and 9.3 shall be met.

C1.1.2 Trade-Off Limits (Section G1.3 of ANSI/ASHRAE/IES Standard 90.1). In addition to the requirements in Section G1.3 of ANSI/ASHRAE/IES Standard 90.1, future building components shall meet all requirements in Section 7.4.

C1.1.3 Documentation Requirements (Section G1.4 of ANSI/ASHRAE/IES Standard 90.1)

a. In addition to the requirements in Section G1.4(d) of ANSI/ASHRAE/IES Standard 90.1, the documentation list shall include compliance with the requirements in Section 7.3.
b. In addition to the requirements in Section G1.4(e) of ANSI/ASHRAE/IES Standard 90.1, the documentation list shall identify aspects that are less stringent than the requirements in Section 7.4.
c. In addition to the requirements in Section G1.4(f) of ANSI/ASHRAE/IES Standard 90.1, the documentation list shall include a table with a summary of CO_2e by end use in the *proposed building performance*.

C1.1.4 Renewable, Recovered, and Purchased Energy. *On-site renewable energy systems* and *site* recovered energy (Section G2.4.1 of ANSI/ASHRAE/IES Standard 90.1): The modeling requirements for *on-site renewable energy systems* in Section G2.4.1 of ANSI/ASHRAE/IES Standard 90.1 shall not apply and are superseded by Section 15, "Renewable Energy Systems," in Table C1.1.

Annual energy costs (Section G2.4.2 of ANSI/ASHRAE/IES Standard 90.1): Where *on-site renewable energy systems* or *site*-recovered energy are used, the *baseline building design* shall be modeled in accordance with the requirements in Section 15, "Renewable Energy Systems," in Table C1.1. The requirements for *baseline building design* energy source in Section G2.4.2 of ANSI/ASHRAE/IES Standard 90.1 shall not apply.

C1.1.5 Baseline HVAC System Type and Description (Section G3.1.1 of ANSI/ASHRAE/IES Standard 90.1). Exception (4) to Section G3.1.1 of ANSI/ASHRAE/IES Standard 90.1 shall be replaced as follows:

> Kitchens with a total exhaust hood airflow rate greater than 2000 cfm shall use system type 5 or 7 with a demand ventilation system on 75% of the exhaust air. The system shall reduce exhaust and replacement airflow rates by 50% for one-half of the kitchen occupied hours in the baseline design. If the *proposed design* uses demand ventilation, the same airflow rate schedule shall be used. The maximum exhaust flow rate allowed for the hood or hood section shall meet the requirements of Section 7.4.3.7.1 for the numbers and types of hoods and appliances provided for in the *proposed design*. For all-electric buildings, the heating shall be electric resistance.

C1.1.6 Equipment Efficiencies (Section G3.1.2.1 of ANSI/ASHRAE/IES Standard 90.1). Section G3.1.2.1 of ANSI/ASHRAE/IES Standard 90.1 is superseded by the requirements of Section 10, "HVAC Systems," in Table C1.1.

C1.1.7 Ventilation (Section G3.1.2.6 of ANSI/ASHRAE/IES Standard 90.1)

a. Exception (1) to Section G3.1.2.6 of ANSI/ASHRAE/IES Standard 90.1 shall be used only where *DCV* is not required by Section 7.4.3.2.
b. Exception (3) to Section G3.1.2.6 of ANSI/ASHRAE/IES Standard 90.1 shall not apply.

C1.1.8 Economizers (Section G3.1.2.7 of ANSI/ASHRAE/IES Standard 90.1)

a. *Outdoor air* economizers shall be included in the baseline systems identified in Section G3.1.2.7 of ANSI/ASHRAE/IES Standard 90.1 for the *climate zones* and capacities specified in Table 7.4.3.3A.
b. Exception (1) to Section G3.1.2.7 of ANSI/ASHRAE/IES Standard 90.1 shall not apply.

C1.1.9 System Fan Power (Section G3.1.2.10 of ANSI/ASHRAE/IES Standard 90.1)

a. System fan brake horsepower shall be 10% less than the values calculated using Section G3.1.2.10 of ANSI/ASHRAE/IES Standard 90.1.
b. Fan motor efficiency shall meet the requirements of Section 7.4.7.1.

C1.1.10 Exhaust Air Energy Recovery (Section G3.1.2.11 of ANSI/ASHRAE/IES Standard 90.1). Exhaust air energy recovery shall be modeled in the *baseline building design* as specified in Section 7.4.3.6.

C1.1.11 System-Specific Baseline HVAC System Requirements (Section G3.1.3 of ANSI/ASHRAE/IES Standard 90.1). Heat Rejection (Section G3.1.3.11 of ANSI/ASHRAE/IES Standard 90.1): In addition to the requirements in Section G3.1.3.11 of ANSI/ASHRAE/IES Standard 90.1, the heat-rejection device shall meet the performance requirements in Table B-8.

C1.1.12 *Variable-Air-Volume* (*VAV*) Minimum Flow Setpoints (Section G3.1.3.13 of ANSI/ASHRAE/IES Standard 90.1). Zone minimum airflow setpoints shall be modeled as specified in Section 7.4.3.4.

C1.1.13 Building Performance Calculations (Table G3.1 of ANSI/ASHRAE/IES Standard 90.1). In addition to Table G3.1 of ANSI/ASHRAE/IES Standard 90.1, the *baseline building design* and *proposed design* shall comply with all modifications and additions in Table C1.1. All references to "Table G3.1" in Table C1.1 refer to Table G3.1 of Appendix G of ANSI/ASHRAE/IES Standard 90.1.

TABLE C1.1 Modifications and Additions to Table G3.1 of Appendix G in ANSI/ASHRAE/IES Standard 90.1

Proposed Building Performance	*Baseline Building Performance*
1. Design Model	
No modifications	No modifications
2. Additions and Alterations	
In addition to the requirements in Table G3.1(2)(a), work to be performed in the excluded parts of the building shall comply with Sections 7.3 and 7.4.	No modifications
3. *Space* Use Classification	
No modifications	No modifications
4. Schedules	
No modifications	No modifications
5. *Building Envelope*	
Exception (3) of Table G3.1(5) shall be replaced with the following: The exterior *roof* surface shall be modeled using the solar reflectance and thermal emittance determined in accordance with Sections 5.3.5.3 and 5.3.5.4. Where test data are unavailable, the *roof* surface shall be modeled with a solar reflectance of 0.30 and a thermal emittance of 0.90.	a. In addition to the requirements in Table G3.1(5), the *baseline building design* shall comply with Section 7.4.2, not including Section 7.4.2.8. b. The *baseline building performance* shall be equal to the lowest annual energy cost of the following four simulations: the building in its actual orientation and the building rotated 90, 180, and 270 degrees. **Exception to (b):** *Building projects that qualify for* Exceptions (1) or (2) to Table G3.1(5)(a) are not required to have the building model rotated. c. In addition to the requirements in Table G3.1(5)(f) and G3.1(5)(g), *roof* surfaces shall comply with Sections 5.3.4.3.
6. Lighting	
a. In addition to the requirements in Table G3.1(6)(c), when lighting neither exists nor is specified, lighting power shall comply with Section 7.4.6. b. When taking credit for daylight controls under Table G3.1(6)(f), credit may be taken only for lighting controls that are not required by Section 7.4.6. Credit for daylighting controls is allowed to be taken up to a distance of 2.5 times window head height where all lighting more than one window head height from the perimeter (head height is the distance from the floor to the top of the glazing) is automatically controlled separately from lighting within one window head height of the perimeter.	In addition to the requirements in Table G3.1(6), lighting power shall comply with Section 7.4.6. *Automatic* and manual controls shall be modeled as required in Section 7.4.6.
7. Thermal Blocks—HVAC Zones Designed	
No modifications	No modifications
8. Thermal Blocks—HVAC Zones Not Designed	
No modifications	No modifications
9. Thermal Blocks—Multifamily *Residential* Buildings	
No modifications	No modifications
10. HVAC Systems	
The HVAC system type and all related performance parameters in the *proposed design*, such as equipment capacities and efficiencies, shall be determined as follows: Where a complete HVAC system exists, the model shall reflect the actual system type using actual component capacities and efficiencies. a. Where an HVAC system has been designed, the HVAC model shall be consistent with design documents. Mechanical equipment efficiencies shall be adjusted from actual design conditions to the standard rating conditions specified in Section 7.4.3 and Normative Appendix C if required by the simulation model. b. Where no heating system exists or no heating system has been specified, the heating system classification shall be assumed to be electric, and the system characteristics shall be identical to the system modeled in the *baseline building design*. Where no cooling system exists or no cooling system has been specified, the cooling system shall be identical to the system modeled in the *baseline building design*.	The HVAC system(s) in the *baseline building design* shall be of the type and description specified in Section G3.1.1, shall comply with the general HVAC system requirements specified in Section G3.1.2, shall comply with any system-specific requirements in Section G3.1.3 that are applicable to the baseline HVAC system type(s), and shall comply with Sections 7.3 and 7.4.3 under the standard renewables approach as described in Section 7.4.1.1.1. The equipment efficiency requirements in Section 7.4.3.1 do not apply to the *baseline building design*.

TABLE C1.1 Modifications and Additions to Table G3.1 of Appendix G in ANSI/ASHRAE/IES Standard 90.1 *(Continued)*

Proposed Building Performance	*Baseline Building Performance*
11. Service Hot-Water Systems	
In addition to the requirements in Table G3.1(11), service hot-water usage is allowed to be lower in the *proposed design* than in the *baseline building design* if service hot-water use can be demonstrated to be less than that resulting from compliance with Sections 6.3.2, 6.4.2, and 6.4.3.	a. In addition to the requirements in Table G3.1 (11.b) and (11.c), service hot-water systems shall meet the requirements of Sections 7.4.4.1, 7.4.7.2, and 7.4.7.3. b. In addition to the requirements in Table G3.1 (11.f), the *baseline building design* shall meet the requirements of Section 7.4.7.2. If a condenser heat recovery system meeting the requirements described in Section 7.4.7.2 cannot be modeled, the requirement for including such a system in the actual building shall be met as a prescriptive requirement and no heat-recovery system shall be included in the *proposed design* or *baseline building design*. c. In addition to the requirements in Table G3.1 (11.i), the *baseline building design* shall meet the requirements of Sections 6.3.2 and 6.4.3.
12. Receptacle and Other Loads	
No modifications	In addition to the requirements in Table G3.1(12), the *baseline building design* must meet the requirements in Section 7.4.7; except for the equipment efficiency requirements in Section 7.4.7.1, the ENERGY STAR® requirements in Section 7.4.7.3.2, and equipment efficiency requirements in Normative Appendix B.
13. Modeling Limitations to the Simulation Program	
No modifications	No modifications
14. Exterior Conditions	
No modifications	No modifications
15. *On-Site Renewable Energy Systems*	
The reduction in the *proposed building performance* and annual CO_2e of the *proposed design* due to energy generated by *on-site renewable energy systems* shall be calculated as follows: a. **Annual Energy Cost.** The annual energy cost of the *proposed design* with an *on-site renewable energy system* shall be calculated on an hourly basis and adjusted as follows. 1. **Thermal Energy Performance Calculation.** The hourly thermal loads of the *proposed design* shall be reduced by the hourly thermal energy production of the *on-site renewable energy system* (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption. 2. **Electric Energy Performance Calculation.** The total electrical energy production of the *on-site renewable energy system* shall be calculated on an hourly basis and the energy cost of the *proposed building performance* shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the *on-site renewable energy system.* **Exception to (a):** For *building projects* with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the *on-site renewable energy system*, but the cost of imported electricity shall not be less than zero on a monthly basis.	The *baseline building design* shall include an *on-site renewable energy system* that generates an annual amount of energy equal to that required under the standard renewables approach as described in Section 7.4.1.1.1. The *on-site renewable energy system* shall reduce the annual energy cost and the annual CO_2e. a. **Annual Energy Cost.** The reduction in annual energy cost of the *baseline building performance* due to on-site renewable production shall be equal to the amount of on-site renewable energy production required in under the standard renewables approach as described in Section 7.4.1.1.1 multiplied by the average energy rate for the *baseline building design*. The average energy rate shall be equal to the calculated total annual cost of energy to serve the baseline building divided by the total annual *site* energy consumption of the building not including reductions in consumption from on-site renewable energy production. b. **Annual CO_2e.** The reduction in annual CO_2e of the baseline building due to on-site renewable production shall be equal to the amount of on-site renewable energy production required under the standard renewables approach as described in Section 7.4.1.1.1 multiplied by the average CO_2e rate for the *baseline building design.* The average CO_2e rate shall be equal to the calculated total annual CO_2e for all types of imported energy used by the baseline building divided by the total annual *site* energy consumption of the building not including reductions in consumption from on-site renewable energy production. **Exception to (b):** When the *proposed design* qualifies for the exception to Section 7.4.1.1.1, an *on-site renewable energy system* shall not be included in the *baseline building design*.

TABLE C1.1 Modifications and Additions to Table G3.1 of Appendix G in ANSI/ASHRAE/IES Standard 90.1 *(Continued)*

Proposed Building Performance	*Baseline Building Performance*
15. *On-Site Renewable Energy Systems* (contd.)	
Exception to (a) (contd.): Electricity production of the *on-site renewable energy system* which has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the *building performance* at the wholesale rate as follows. $\text{Credit} = \frac{(\text{ExRR} - \text{ImRR})}{\text{ExRR}} \times \text{ExkWh} \times \text{WR}$ where Credit = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity ExRR = month's value of exported electricity at retail rate ImRR = month's value of imported electricity at retail rate ExkWh = total kilowatt-hours exported in month WR = average monthly wholesale rate for the region where the building located	
b. **Annual CO_2e.** The annual CO_2e of the proposed building that includes an *on-site renewable energy system* shall be equal to the annual CO_2e of the imported energy to serve the proposed building (with reduced loads due to the *on-site renewable energy system*) minus the annual exported electricity produced by the *on-site renewable energy system* multiplied by the electrical CO_2e emission factor.	
Documentation: The documentation required in Section G2.5(a), (b), and (e) in ASHRAE/IES Standard 90.1 shall be made available to the *AHJ* upon request for all *on-site renewable energy systems* in the *proposed design*.	

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX D
BUILDING CONCENTRATIONS

D1. BUILDING CONCENTRATIONS

Building concentrations shall be estimated based on the following parameters and criteria:

a. Laboratory-measured volatile organic compound (VOC) emission factors and actual surface area of all materials as described in (b) below.
b. At minimum, those materials listed in Section 8.5.2(a) through (g) to be installed shall be modeled.
c. The actual building parameters for volume, average weekly minimum ventilation rate, and ventilated volume fraction for the building being modeled shall be used.
d. Standard building scenarios or modeling from similar buildings shall not be allowed.
e. Average weekly minimum air change rates shall be calculated based on the *minimum outdoor airflow* and hours of operation for the specific building being modeled.
f. Steady-state conditions with respect to emission rates and building ventilation may be assumed.
g. Zero *outdoor air* concentrations, perfect mixing within the building, and no net losses of VOCs from air due to other effects such as irreversible or net sorption on surfaces (i.e., net sink effects) and chemical reactions may be assumed.
h. All assumptions shall be clearly stated in the design documents.
i. The estimated building concentration, C_{Bi} (μg/m^3), of each target VOC shall be calculated using Equation 2 of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350), as shown below. Estimated building concentrations of individual target VOCs with multiple sources shall be added to establish a single total estimated building concentration for individual target VOCs.

$$C_{Bi} = (\mathrm{EF}_{Ai} \times A_B)/(V_B \times a_B \times 0.9)$$

where

EF_{Ai} = area specific emission rate or emission factor at 96 hours after placing a test specimen in the chamber (14 days total exposure time), μg/m^2·h

A_B = exposed surface area of the installed material in the building, m^2

V_B = building volume, m^3

a_B = average weekly minimum air change rate, 1/h

(This appendix 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.)

INFORMATIVE APPENDIX E *BUILDING ENVELOPE* TABLES

The first eight tables are in I-P units, followed by eight tables in SI units. U-factors, C-factors, F-factors, and *SHGC* in these tables meet the requirements of Section 7.4.2.1, although the R-values in most cases provide more insulation than is required in Section 7.4.2.1. These R-values represent common assemblies in building construction. Assemblies with lower R-values are allowed to be used the meet the criteria of Section 7.4.2.1 when they meet the appropriate U-factor, C-factor, or F-factor criteria.

TABLE E-1 (Supersedes Table 5.5-1 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 1 (A,B)* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.048	R-20 c.i.	U-0.039	R-25 c.i.	U-0.218	R-3.8 c.i.
Metal building[a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.115	R-10
Attic and other	U-0.027	R-38	U-0.027	R-38	U-0.081	R-13
Walls, above grade						
Mass	U-0.580	NR	U-0.151[b]	R-5.7 c.i.[b]	U-0.580	NR
Metal building	U-0.094	R-0 + R-9.8 c.i.	U-0.094	R-0 + R-9.8 c.i.	U-0.352	NR
Steel framed	U-0.124	R-13	U-0.124	R-13	U-0.352	NR
Wood framed and other	U-0.089	R-13	U-0.089	R-13	U-0.292	NR
Wall, below grade						
Below-grade *wall*	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.322	NR	U-0.322	NR	U-0.322	NR
Steel joist	U-0.350	NR	U-0.350	NR	U-0.350	NR
Wood framed and other	U-0.282	NR	U-0.282	NR	U-0.282	NR
Slab-on-grade floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.45[c]	E,W, &S-0.25 N-0.35	1.10	U-0.45[c]	E,W, &S-0.25 N-0.35	1.10	U-0.84	NR	NR
Metal framing, fixed	U-0.51[c]			U-0.51[c]			U-1.08		
Metal framing, operable	U-0.59[c]			U-0.59[c]			U-1.08		
Metal framing, entrance door	U-0.99[c]			U-0.99[c]			U-0.99[c]		
Skylight, 0% to 3% of *roof*		0.35			0.35				
All types	U-0.75		NR	U-0.75		NR	U-1.80	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

b. Exception to ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.3.2, applies for mass *walls* above grade.

c. For locations in *Climate Zone* 1 with a cooling design temperature of 95°F and greater, the maximum U-factors for *vertical fenestration* shall be 10% lower than those in ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.4.3.

TABLE E-2 (Supersedes Table 5.5-2 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 2 (A,B)* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.173	R-5 c.i.
Metal building[a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16
Attic and other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19
Walls, above grade						
Mass	U-0.151[b]	R-5.7 c.i.[b]	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal building	U-0.094	R-0 + R-9.8 c.i.	U-0.094	R-0 + R-9.8. c.i.	U-0.162	R-13
Steel framed	U-0.084	R-13 + R-3.8 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
Wood framed and other	U-0.089	R-13	U-0.089	R-13	U-0.089	R-13
Wall, below grade						
Below-grade *wall*	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel joist	U-0.038	R-30	U-0.038	R-30	U-0.069	R-13
Wood framed and other	U-0.033	R-30	U-0.033	R-30	U-0.066	R-13
Slab-on-grade floors						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.900	R-10 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.36	E,W, &S-0.25 N-0.35	1.10	U-0.36	E,W, &S-0.25 N-0.35	1.10	U-0.84	NR	NR
Metal framing, fixed	U-0.51			U-0.51			U-1.08		
Metal framing, operable	U-0.59			U-0.59			U-1.08		
Metal framing, entrance door	U-0.75			U-0.69			U-0.75		
Skylight, 0% to 3% of *roof*		0.35			0.35				
All types	U-0.65		NR	U-0.65		NR	U-1.80	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

b. Exception to ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.3.2, applies for mass *walls* above grade.

TABLE E-3 (Supersedes Table 5.5-3 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 3 (A,B,C)* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.039	R-25 c.i.	U-0.039	R-25 c.i.	U-0.119	R-7.6 c.i.
Metal building[a]	U-0.041	R-10 + R-19 FC	U-0.041	R-10 + R-19 FC	U-0.096	R-16
Attic and other	U-0.027	R-38	U-0.027	R-38	U-0.053	R-19
Walls, above grade						
Mass	U-0.123	R-7.6 c.i.	U-0.104	R-9.5 c.i.	U-0.580	NR
Metal building	U-0.094	R-0 + R-9.8 c.i.	U-0.072	R-0 + R-13 c.i.	U-0.162	R-13
Steel framed	U-0.077	R-13 + R-5 c.i.	U-0.064	R-13 + R-7.5 c.i.	U-0.124	R-13
Wood framed and other	U-0.089	R-13	U-0.064	R-13 + R-3.8 c.i. or R-20	U-0.089	R-13
Wall, below grade						
Below-grade *wall*	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors						
Mass	U-0.074	R-10 c.i.	U-0.074	R-10 c.i.	U-0.137	R-4.2 c.i.
Steel joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
Wood framed and other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
Slab-on-grade floors						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque doors						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.32	E,W, &S-0.25 N-0.35	1.10	U-0.32	E,W, &S-0.25 N-0.35	1.10	U-0.78	NR	NR
Metal framing, fixed	U-0.45			U-0.45			U-1.08		
Metal framing, operable	U-0.54			U-0.54			U-1.08		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*		0.35			0.35				
All types	U-0.55		NR	U-0.55		NR	U-1.70	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

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

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.029	R-35 c.i.	U-0.029	R-35 c.i.	U-0.084	R-12 c.i.
Metal building[a]	U-0.033	R-13 + R-25 c.i.	U-0.033	R-13 + R-25 c.i.	U-0.074	R-0 + R-13 c.i.
Attic and other	U-0.019	R-60	U-0.019	R-60	U-0.031	R-38
Walls, above grade						
Mass	U-0.094	R-11.4c.i.	U-0.081	R-13.0	U-0.580	NR
Metal building	U-0.054	R-11 + R-13 c.i.	U-0.045	R-16 + R-15.8 c.i.	U-0.146	R-0 + R-6.5 c.i.
Steel framed	U-0.058	R-13.0 + R-12.5 c.i.	U-0.058	R-13.0 + R-12.5 c.i.	U-0.112	R-13.0 + R-3.8 c.i.
Wood framed and other	U-0.058	R-13.0 + R-7.5 c.i.	U-0.058	R-13.0 + R-7.5 c.i.	U-0.080	R-13.0 + R-3.8 c.i.
Wall, below grade						
Below-grade *wall*	C-0.107	R-10.0 c.i.	C-0.083	R-12.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.051	R-16.7 c.i.	U-0.046	R-18.7 c.i.	U-0.096	R-8.3 c.i.
Steel joist	U-0.034	R-38.0	U-0.034	R-38.0	U-0.047	R-30.0
Wood framed and other	U-0.030	R-38.0	U-0.030	R-38.0	U-0.046	R-30.0
Slab-on-grade floors						
Unheated	F-0.468	R-20.0 for 48 in.	F-0.468	R-20.0 for 48 in.	F-0.730	NR
Heated	F-0.759	R-20.0 for 48 in.	F-0.619	R-15.0 full slab	F-0.810	R-20.0 for 48 in.
Opaque doors						
Swinging	U-0.450		U-0.450		U-0.630	
Nonswinging	U-0.450		U-0.450		U-1.305	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.32	S-0.40 E&W-0.36 N-0.50	1.10	U-0.32	S-0.40 E&W-0.36 N-0.50	1.10	U-0.46	NR	NR
Metal framing, fixed	U-0.38			U-0.38			U-0.66		
Metal framing, operable	U-0.45			U-0.45			U-0.73		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*		0.40			0.40				
All types	U-0.50		NR	U-0.50		NR	U-1.15	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-5 (Supersedes Table 5.5-5 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 5 (A,B,C)* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.029	R-35 c.i.	U-0.029	R-35 c.i.	U-0.057	R-17 c.i.
Metal building[a]	U-0.033	R-13 + R-25 c.i.	U-0.033	R-13 + R-25 c.i.	U-0.074	R-0 + R-13 c.i.
Attic and other	U-0.019	R-60	U-0.019	R-60	U-0.031	R-38
Walls, above grade						
Mass	U-0.081	R-13.0	U-0.072	R-15.2 c.i.	U-0.136	R-7.5c.i.
Metal building	U-0.045	R-16 + R-15.8 c.i.	U-0.045	R-16 + R-15.8 c.i.	U-0.085	R-11 + R-6.5 c.i.
Steel framed	U-0.050	R-13.0 + R-12.5 c.i.	U-0.050	R-13.0 + R-12.5 c.i.	U-0.076	R-13.0 + R-7.5 c.i.
Wood framed and other	U-0.046	R-13.0 + R-12.5 c.i.	U-0.046	R-13.0 + R-12.5 c.i.	U-0.080	R-13.0 + R-3.8 c.i.
Wall, below grade						
Below-grade *wall*	C-0.107	R-10.0 c.i.	C-0.083	R-12.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.051	R-16.7 c.i.	U-0.046	R-18.7 c.i.	U-0.096	R-8.3 c.i.
Steel joist	U-0.034	R-38.0	U-0.034	R-38.0	U-0.047	R-30.0
Wood framed and other	U-0.030	R-38.0	U-0.030	R-38.0	U-0.046	R-30.0
Slab-on-grade floors						
Unheated	F-0.468	R-20.0 for 48 in.	F-0.459	R-20.0 for 48 in.	F-0.730	NR
Heated	F-0.619	R-15.0 full slab	F-0.619	R-15.0 full slab	F-0.810	R-20.0 for 48 in.
Opaque doors						
Swinging	U-0.450		U-0.450		U-0.630	
Nonswinging	U-0.450		U-0.450		U-1.305	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/ *SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	S-0.40 E&W-0.36 N-0.50	1.10	U-0.29	S-0.40 E&W-0.36 N-0.50	1.10	U-0.41	NR	NR
Metal framing, fixed	U-0.38			U-0.38			U-0.56		
Metal framing, operable	U-0.45			U-0.45			U-0.63		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*		0.40			0.40				
All types	U-0.50		NR	U-0.50		NR	U-0.98	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-6 (Supersedes Table 5.5-6 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 6 (A,B)* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.029	R-35 c.i.	U-0.029	R-35 c.i.	U-0.057	R-17 c.i.
Metal building[a]	U-0.028	R-11 + R-32 c.i.	U-0.026	R-19 + R-32 c.i.	U-0.054	R-11 + R-13 c.i.
Attic and other	U-0.019	R-60	U-0.019	R-60	U-0.031	R-38
Walls, above grade						
Mass	U-0.072	R-15.2 c.i.	U-0.064	R-19.6 c.i.	U-0.136	R-7.5c.i.
Metal building	U-0.045	R-16 + R-15.8 c.i.	U-0.045	R-16 + R-15.8 c.i.	U-0.085	R-11 + R-6.5 c.i.
Steel framed	U-0.044	R-13.0 + R-15.6 c.i.	U-0.044	R-13.0 + R-15.6 c.i.	U-0.076	R-13.0 + R-7.5 c.i.
Wood framed and other	U-0.046	R-13.0 + R-12.5 c.i.	U-0.046	R-13.0 + R-12.5 c.i.	U-0.080	R-13.0 + R-3.8 c.i.
Wall, below grade						
Below-grade *wall*	C-0.083	R-12.5 c.i.	C-0.057	R-17.5 c.i.	C-0.107	R-10.0 c.i.
Floors						
Mass	U-0.046	R-18.7 c.i.	U-0.046	R-18.7 c.i.	U-0.078	R-10.4 c.i.
Steel joist	U-0.029	R-49.0	U-0.029	R-49.0	U-0.047	R-30.0
Wood framed and other	U-0.024	R-38.0+ R-7.5 c.i.	U-0.024	R-38.0 + R-7.5 c.i.	U-0.046	R-30.0
Slab-on-grade floors						
Unheated	F-0.459	R-20.0 for 48 in.	F-0.391	R-15.0 full slab	F-0.730	NR
Heated	F-0.619	R-15.0 full slab	F-0.604	R-15.0 full slab	F-0.774	R-20.0 for 48 in.
Opaque doors						
Swinging	U-0.450		U-0.450		U-0.630	
Nonswinging	U-0.450		U-0.450		U-0.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	S-0.40 E&W-0.36 N-0.50	1.10	U-0.29	S-0.40 E&W-0.36 N-0.50	1.10	U-0.41	NR	NR
Metal framing, fixed	U-0.38			U-0.38			U-0.46		
Metal framing, operable	U-0.45			U-0.45			U-0.53		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*		0.40			0.40				
All types	U-0.50		NR	U-0.50		NR	U-0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (ANSI/ASHRAE/IES Standard 90.1-2013, see Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-7 (Supersedes Table 5.5-7 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 7* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.025	R-40 c.i.	U-0.025	R-40 c.i.	U-0.035	R-28 c.i.
Metal building[a]	U-0.026	R-19 + R-32 c.i.	U-0.026	R-19 + R-32 c.i.	U-0.033	R-13 + R-25 c.i.
Attic and other	U-0.015	R-71	U-0.015	R-71	U-0.024	R-49
Walls, above grade						
Mass	U-0.064	R-19.6 c.i.	U-0.064	R-19.6 c.i.	U-0.111	R-9.5 c.i.
Metal building	U-0.040	R-19 + R-19 c.i.	U-0.040	R-19 + R-19 c.i.	U-0.065	R-13 + R-9.8 c.i.
Steel framed	U-0.044	R-13.0 + R-15.6 c.i.	U-0.038	R-13.0 + R-18.8 c.i.	U-0.058	R-13.0 + R-12.5 c.i.
Wood framed and other	U-0.046	R-13.0 + R-12.5 c.i.	U-0.046	R-13.0 + R-12.5 c.i.	U-0.058	R-13.0 + R-7.5 c.i.
Wall, below grade						
Below-grade *wall*	C-0.057	R-17.5 c.i.	C-0.057	R-17.5 c.i.	C-0.107	R-10.0 c.i.
Floors						
Mass	U-0.038	R-25.1 c.i.	U-0.038	R-25.1 c.i.	U-0.067	R-12.5 c.i.
Steel joist	U-0.029	R-49.0	U-0.029	R-49.0	U-0.047	R-30.0
Wood framed and other	U-0.024	R-38.0+ R-7.5 c.i.	U-0.024	R-38.0 + R-7.5 c.i.	U-0.046	R-30.0
Slab-on-grade floors						
Unheated	F-0.459	R-20.0 for 48 in.	F-0.391	R-15.0 full slab	F-0.730	NR
Heated	F-0.604	R-15.0 full slab	F-0.604	R-15.0 full slab	F-0.774	R-20.0 for 48 in.
Opaque doors						
Swinging	U-0.450		U-0.450		U-0.630	
Nonswinging	U-0.450		U-0.450		U-0.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	S-0.45 E&W-0.41 N-0.55	1.10	U-0.29	S-0.45 E&W-0.41 N-0.55	1.10	U-0.29	NR	NR
Metal framing, fixed	U-0.34			U-0.34			U-0.34		
Metal framing, operable	U-0.36			U-0.36			U-0.40		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*									
All types	U-0.50	NR	NR	U-0.50	NR	NR	U-0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-8 (Supersedes Table 5.5-8 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 8* (I-P)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.025	R-40 c.i.	U-0.025	R-40 c.i.	U-0.035	R-28 c.i.
Metal building[a]	U-0.023	R-16 + R-38 c.i.	U-0.023	R-16 + R-38 c.i.	U-0.033	R-13 + R-25 c.i.
Attic and other	U-0.015	R-71	U-0.015	R-71	U-0.024	R-49
Walls, above grade						
Mass	U-0.043	R-22.0 c.i.	U-0.043	R-22.0 c.i.	U-0.094	R-11.4c.i.
Metal building	U-0.035	R-19 + R-22.1 c.i.	U-0.035	R-19 + R-22.1 c.i.	U-0.054	R-11 + R-13 c.i.
Steel framed	U-0.033	R-13.0 + R-25 c.i.	U-0.033	R-13.0 + R-25 c.i.	U-0.058	R-13.0 + R-12.5 c.i.
Wood framed and other	U-0.029	R-13.0 + R-25 c.i.	U-0.029	R-13.0 + R-25 c.i.	U-0.046	R-13.0 + R-12.5 c.i.
Wall, below grade						
Below-grade *wall*	C-0.057	R-17.5 c.i.	C-0.057	R-17.5 c.i.	C-0.107	R-10.0 c.i.
Floors						
Mass	U-0.034	R-27.2 c.i.	U-0.034	R-27.2 c.i.	U-0.058	R-14.6 c.i.
Steel joist	U-0.029	R-49.0	U-0.029	R-49.0	U-0.047	R-30.0
Wood framed and other	U-0.024	R-38.0+ R-7.5 c.i.	U-0.024	R-38.0 + R-7.5 c.i.	U-0.030	R-38.0
Slab-on-grade floors						
Unheated	F-0.391	R-15.0 full slab	F-0.382	R-15.0 full slab	F-0.486	R-20.0 for 48 in.
Heated	F-0.604	R-15.0 full slab	F-0.336	R-25.0 full slab	F-0.774	R-20.0 for 48 in.
Opaque doors						
Swinging	U-0.450		U-0.450		U-0.450	
Nonswinging	U-0.450		U-0.450		U-0.450	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	S-0.45 E&W-0.41 N-0.55	1.10	U-0.29	S-0.45 E&W-0.41 N-0.55	1.10	U-0.29	NR	NR
Metal framing, fixed	U-0.34			U-0.34			U-0.34		
Metal framing, operable	U-0.36			U-0.36			U-0.40		
Metal framing, entrance door	U-0.69			U-0.61			U-0.69		
Skylight, 0% to 3% of *roof*									
All types	U-0.50	NR	NR	U-0.50	NR	NR	U-0.85	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-1 (Supersedes Table 5.5-1 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 1 (A,B)* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.273	R-3.5 c.i.	U-0.220	R-4.4 c.i.	U-1.240	R-0.7 c.i.
Metal building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.653	R-1.8
Attic and other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.459	R-2.3
Walls, above grade						
Mass	U-3.293	NR	U-0.857[b]	R-1.0 c.i.[b]	U-3.293	NR
Metal building	U-0.533	R-0 + R-1.7 c.i.	U-0.533	R-0 + R-1.7 c.i.	U-1.998	NR
Steel framed	U-0.705	R-2.3	U-0.705	R-2.3	U-1.998	NR
Wood framed and other	U-0.504	R-2.3	U-0.504	R-2.3	U-1.660	NR
Wall, below grade						
Below-grade *wall*	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-1.825	NR	U-1.825	NR	U-1.825	NR
Steel joist	U-1.986	NR	U-1.986	NR	U-1.986	NR
Wood framed and other	U-1.599	NR	U-1.599	NR	U-1.599	NR
Slab-on-grade floors						
Unheated	F-1.264	NR	F-1.264	NR	F-1.264	NR
Heated	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm	F-1.766	R-1.3 for 300 mm
Opaque doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-8.233		U-2.839		U-8.233	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.56[c]	E,W, &S-0.25 N-0.35	1.10	U-2.56[c]	E,W, &S-0.25 N-0.35	1.10	U-4.75	NR	NR
Metal framing, fixed	U-2.91[c]			U-2.91[c]			U-6.13		
Metal framing, operable	U-3.32[c]			U-3.32[c]			U-6.13		
Metal framing, entrance door	U-5.62[c]			U-5.62[c]			U-5.62[c]		
Skylight, 0% to 3% of *roof*									
All types	U-4.26	0.35	NR	U-4.26	0.35	NR	U-10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

b. Exception to ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.3.2, applies for mass *walls* above grade.

c. For locations in *Climate Zone* 1 with a cooling design temperature of 35°C and greater, the maximum U-factors for *vertical fenestration* shall be 10% lower than those in ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.4.3.

TABLE E-2 (Supersedes Table 5.5-2 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 2 (A,B)* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.220	R-4.4 c.i.	U-0.220	R-4.4 c.i.	U-0.982	R-0.9 c.i.
Metal building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.545	R-2.8
Attic and other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, above grade						
Mass	U-0.857[b]	R-1.0 c.i.[b]	U-0.701	R-1.3 c.i.	U-3.293	NR
Metal building	U-0.533	R-0 + R-1.7 c.i.	U-0.533	R-0 + R-1.7 c.i.	U-0.920	R-2.3
Steel framed	U-0.479	R-2.3 + R-0.7 c.i.	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood framed and other	U-0.504	R-2.3	U-0.504	R-2.3	U-0.504	R-2.3
Wall, below grade						
Below-grade *wall*	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-0.606	R-1.9	U-0.496	R-1.5	U-1.825	NR
Steel joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.390	R-2.3
Wood framed and other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.376	R-2.3
Slab-on-grade floors						
Unheated	F-1.264	NR	F-1.264	NR	F-1.264	NR
Heated	F-1.558	R-1.8 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.04	E,W, &S-0.25 N-0.35	1.10	U-2.04	E,W, &S-0.25 N-0.35	1.10	U-4.75	NR	NR
Metal framing, fixed	U-2.91			U-2.91			U-6.13		
Metal framing, operable	U-3.32			U-3.32			U-6.13		
Metal framing, entrance door	U-4.24			U-3.94			U-4.24		
Skylight, 0% to 3% of *roof*									
All types	U-3.69	0.35	NR	3.69	035	NR	U-10.22	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls* = *liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

b. Exception to ANSI/ASHRAE/IES Standard 90.1-2013, Section 5.5.3.2, applies for mass *walls* above grade.

TABLE E-3 (Supersedes Table 5.5-3 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 3 (A,B,C)* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.220	R-4.4 c.i.	U-0.220	R-4.4 c.i.	U-0.677	R-1.3 c.i.
Metal building[a]	U-0.233	R-1.8 + R-3.3 FC	U-0.233	R-1.8 + R-3.3 FC	U-0.545	R-2.8
Attic and other	U-0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, above grade						
Mass	U-0.701	R-1.3 c.i.	U-0.592	R-1.7 c.i.	U-3.293	NR
Metal building	U-0.533	R-0 + R-1.7 c.i.	U-0.410	R-0 + R-2.3 c.i.	U-0.920	R-2.3
Steel framed	U-0.435	R-2.3 + R-0.9 c.i.	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood framed and other	U-0.504	R-2.3	U-0.365	R-2.3 + R-0.7 c.i. or R-3.5	U-0.504	R-2.3
Wall, below grade						
Below-grade *wall*	C-6.473	NR	C-6.473	NR	C-6.473	NR
Floors						
Mass	U-0.420	R-1.8 c.i.	U-0.420	R-1.8 c.i.	U-0.780	R-0.7 c.i.
Steel joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.296	R-3.3
Wood framed and other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.288	R-3.3
Slab-on-grade floors						
Unheated	F-1.264	NR	F-0.935	R-1.8 for 600 mm	F-1.264	NR
Heated	F-1.489	R-2.6 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque doors						
Swinging	U-3.975		U-2.839		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.79	E,W, &S-0.25 N-0.35	1.10	U-1.79	E,W, &S-0.25 N-0.35	1.10	U-4.45	NR	NR
Metal framing, fixed	U-2.56			U-2.56			U-6.13		
Metal framing, operable	U-3.07			U-3.07			U-6.13		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-3.12	0.35	NR	U-3.12	0.35	NR	U-9.65	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-4 (Supersedes Table 5.5-4 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 4 (A,B,C)* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.164	R-6.2 c.i.	U-0.164	R-6.2 c.i.	U-0.475	R-2.1 c.i.
Metal building[a]	U-0.189	R-2.3 + R-4.4 c.i.	U-0.189	R-2.3 + R-4.4 c.i.	U-0.419	R-0 + R-2.3 c.i.
Attic and other	U-0.107	R-10.6	U-0.107	R-10.6	U-0.174	R-6.7
Walls, above grade						
Mass	U-0.532	R-2.01	U-0.460	R-2.29	U-3.293	NR
Metal building	U-0.307	R-1.9 + R-2.3 c.i.	U-0.256	R-2.8 + R-2.8 c.i.	U-0.828	R-0 + R-1.1 c.i.
Steel framed	U-0.327	R-2.3 + R-2.2 c.i.	U-0.327	R-2.3 + R-2.2 c.i.	U-0.634	R-2.3+ R-0.7 c.i.
Wood framed and other	U-0.327	R-2.3 + R-1.3 c.i.	U-0.327	R-2.3 + R-1.3 c.i.	U-0.455	R-2.3+ R-0.7 c.i.
Wall, below grade						
Below-grade *wall*	C-0.608	R-1.8 c.i.	C-0.4703	R-2.2 c.i.	C-6.473	NR
Floors						
Mass	U-0.291	R-2.9 c.i.	U-0.2607	R-3.3 c.i.	U-0.547	R-1.5 c.i.
Steel joist	U-0.194	R-6.7	U-0.194	R-6.7	U-0.266	R-5.3
Wood framed and other	U-0.169	R-6.7	U-0.169	R-6.7	U-0.261	R-5.3
Slab-on-grade floors						
Unheated	F-2.658	R-3.5 for 1200 mm	F-2.658	R-3.5 for 1200 mm	F-1.264	NR
Heated	F-4.309	R-3.5 for 1200 mm	F-3.5171	R-2.6 full slab	F-4.601	R-3.5 for 1200 mm
Opaque doors						
Swinging	U-2.556		U-2.556		U-3.578	
Nonswinging	U-2.556		U-2.556		U-7.412	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.79	S-0.40 E&W-0.36 N-0.50	1.10	U-1.79	S-0.40 E&W-0.36 N-0.50	1.10	U-2.61	NR	NR
Metal framing, fixed	U-2.15			U-2.15			U-3.73		
Metal framing, operable	U-2.56			U-2.56			U-4.14		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-2.84	0.40	NR	U-2.84	0.40	NR	U-6.53	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-5 (Supersedes Table 5.5-5 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 5 (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.164	R-6.2 c.i.	U-0.164	R-6.2 c.i.	U-0.322	R-3.0 c.i.
Metal building[a]	U-0.189	R-2.3 + R-4.4 c.i.	U-0.189	R-2.3 + R-4.4 c.i.	U-0.419	R-0 + R-2.3 c.i.
Attic and other	U-0.107	R-10.6	U-0.107	R-10.6	U-0.174	R-6.7
Walls, above grade						
Mass	U-0.460	R-2.29	U-0.409	R-2.68	U-0.772	R-1.32
Metal building	U-0.256	R-2.8 + R-2.8 c.i.	U-0.256	R-2.8 + R-2.8 c.i.	U-0.481	R-1.9 + R-1.1 c.i.
Steel framed	U-0.281	R-2.3 + R-2.2 c.i.	U-0.281	R-2.3 + R-2.2 c.i.	U-0.429	R-2.3+ R-1.3 c.i.
Wood framed and other	U-0.261	R-2.3 + R-2.2 c.i.	U-0.261	R-2.3 + R-2.2 c.i.	U-0.455	R-2.3+ R-0.7 c.i.
Wall, below grade						
Below-grade *wall*	C-0.608	R-1.8c.i.	C-0.4703	R-2.2 c.i.	C-6.473	NR
Floors						
Mass	U-0.291	R-2.9 c.i.	U-0.2607	R-3.3 c.i.	U-0.547	R-1.5 c.i.
Steel joist	U-0.194	R-6.7	U-0.194	R-6.7	U-0.266	R-5.3
Wood framed and other	U-0.169	R-6.7	U-0.169	R-6.7	U-0.261	R-5.3
Slab-on-grade floors						
Unheated	F-2.658	R-3.5 for 1200 mm	F-2.607	R-3.5 for 1200 mm	F-1.264	NR
Heated	F-3.517	R-2.6 full slab	F-3.5171	R-2.6 full slab	F-4.601	R-3.5 for 1200 mm
Opaque doors						
Swinging	U-2.556		U-2.556		U-3.578	
Nonswinging	U-2.556		U-2.556		U-7.412	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.64	S-0.40 E&W-0.36 N-0.50	1.10	U-1.64	S-0.40 E&W-0.36 N-0.50	1.10	U-2.30	NR	NR
Metal framing, fixed	U-2.15			U-2.15			U-3.17		
Metal framing, operable	U-2.56			U-2.56			U-3.58		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-2.84	0.40	NR	U-2.84	0.40	NR	U-5.56	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-6 (Supersedes Table 5.5-6 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 6 (A,B)* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.164	R-6.2 c.i.	U-0.164	R-6.2 c.i.	U-0.322	R-3.0 c.i.
Metal building[a]	U-0.158	R-1.9 + R-5.6 c.i.	U-0.148	R-3.3 + R-5.6 c.i.	U-0.307	R-1.9 + R-2.3 c.i.
Attic and other	U-0.107	R-10.6	U-0.107	R-10.6	U-0.174	R-6.7
Walls, above grade						
Mass	U-0.409	R-2.68	U-0.363	R-3.45	U-0.772	R-1.32
Metal building	U-0.256	R-2.8 + R-2.8 c.i.	U-0.256	R-2.8 + R-2.8 c.i.	U-0.481	R-1.9 + R-1.1 c.i.
Steel framed	U-0.250	R-2.3 + R-2.7 c.i.	U-0.250	R-2.3 + R-2.7 c.i.	U-0.429	R-2.3+ R-1.3 c.i.
Wood framed and other	U-0.261	R-2.3 + R-2.2 c.i.	U-0.261	R-2.3 + R-2.2 c.i.	U-0.455	R-2.3+ R-0.7 c.i.
Wall, below grade						
Below-grade *wall*	C-0.470	R-2.2 c.i.	C-0.3221	R-3.1 c.i.	C-0.6083	R-1.8 c.i.
Floors						
Mass	U-0.261	R-3.3 c.i.	U-0.2607	R-3.3 c.i.	U-0.445	R-1.8 c.i.
Steel joist	U-0.164	R-8.6	U-0.164	R-8.6	U-0.266	R-5.3
Wood framed and other	U-0.138	R-6.7+ R-1.3 c.i.	U-0.138	R-6.7+ R-1.3 c.i.	U-0.261	R-5.3
Slab-on-grade floors						
Unheated	F-2.607	R-3.5 for 1200 mm	F-2.219	R-2.6 full slab	F-1.264	NR
Heated	F-3.517	R-2.6 full slab	F-3.4302	R-2.6 full slab	F-4.396	R-3.5 for 1200 mm
Opaque doors						
Swinging	U-2.556		U-2.556		U-3.578	
Nonswinging	U-2.556		U-2.556		U-2.556	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.64	S-0.40 E&W-0.36 N-0.50	1.10	U-1.64	S-0.40 E&W-0.36 N-0.50	1.10	U-2.30	NR	NR
Metal framing, fixed	U-2.15			U-2.15			U-2.61		
Metal framing, operable	U-2.56			U-2.56			U-3.02		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-2.84	0.40	NR	U-2.84	0.40	NR	U-4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (ANSI/ASHRAE/IES Standard 90.1-2013, see Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-7 (Supersedes Table 5.5-7 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 7* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.143	R-7.0 c.i.	U-0.143	R-7.0 c.i.	U-0.199	R-4.9 c.i.
Metal building[a]	U-0.148	R-3.3 + R-5.6 c.i.	U-0.148	R-3.3 + R-5.6 c.i.	U-0.189	R-2.3 + R-4.4 c.i.
Attic and other	U-0.087	R-12.5	U-0.087	R-12.5	U-0.138	R-8.6
Walls, above grade						
Mass	U-0.363	R-3.45	U-0.363	R-3.45	U-0.629	R-1.67
Metal building	U-0.225	R-3.3 + R-3.3 c.i.	U-0.225	R-3.3 + R-3.3 c.i.	U-0.368	R-2.3 + R-1.71 c.i.
Steel framed	U-0.250	R-2.3 + R-2.7 c.i.	U-0.215	R-2.3 + R-3.3 c.i.	U-0.327	R-2.3+ R-2.2 c.i.
Wood framed and other	U-0.261	R-2.3 + R-2.2 c.i.	U-0.261	R-2.3 + R-2.2 c.i.	U-0.327	R-2.3+ R-1.3 c.i.
Wall, below grade						
Below-grade *wall*	C-0.322	R-3.1 c.i.	C-0.3221	R-3.1 c.i.	C-0.6083	R-1.8 c.i.
Floors						
Mass	U-0.215	R-4.4 c.i.	U-0.2147	R-4.4 c.i.	U-0.378	R-2.2 c.i.
Steel joist	U-0.164	R-8.6	U-0.164	R-8.6	U-0.266	R-5.3
Wood framed and other	U-0.138	R-6.7+ R-1.3 c.i.	U-0.138	R-6.7+ R-1.3 c.i.	U-0.261	R-5.3
Slab-on-grade floors						
Unheated	F-2.607	R-3.5 for 1200 mm	F-2.219	R-2.6 full slab	F-1.264	NR
Heated	F-3.430	R-2.6 full slab	F-3.4302	R-2.6 full slab	F-4.396	R-3.5 for 1200 mm
Opaque doors						
Swinging	U-2.556		U-2.556		U-3.578	
Nonswinging	U-2.556		U-2.556		U-2.556	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.64	S-0.45 E&W-0.41 N-0.55	1.10	U-1.64	S-0.45 E&W-0.41 N-0.55	1.10	U-1.64	NR	NR
Metal framing, fixed	U-1.94			U-1.94			U-1.94		
Metal framing, operable	U-2.04			U-2.04			U-2.25		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-2.84	NR	NR	U-2.84	NR	NR	U-4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

TABLE E-8 (Supersedes Table 5.5-8 in ANSI/ASHRAE/IES Standard 90.1)
***Building Envelope* Requirements for *Climate Zone* 8* (SI)**

	Nonresidential		*Residential*		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation entirely above deck	U-0.143	R-7.0 c.i.	U-0.143	R-7.0 c.i.	U-0.199	R-4.9 c.i.
Metal building[a]	U-0.133	R-2.8 + R-6.7 c.i.	U-0.133	R-2.8 + R-6.7 c.i.	U-0.189	R-2.3 + R-4.4 c.i.
Attic and other	U-0.087	R-12.5	U-0.087	R-12.5	U-0.138	R-8.6
Walls, above grade						
Mass	U-0.245	R-3.87 c.i.	U-0.245	R-3.87 c.i.	U-0.532	R-2.01
Metal building	U-0.199	R-3.3 + R-3.9 c.i.	U-0.199	R-3.3 + R-3.9 c.i.	U-0.307	R-1.9 + R-2.3 c.i.
Steel framed	U-0.189	R-2.3 + R-4.4 c.i.	U-0.189	R-2.3 + R-4.4 c.i.	U-0.327	R-2.3+ R-2.2 c.i.
Wood framed and other	U-0.164	R-2.3 + R-4.4 c.i.	U-0.164	R-2.3 + R-4.4 c.i.	U-0.261	R-2.3+ R-2.2 c.i.
Wall, below grade						
Below-grade *wall*	C-0.322	R-3.1 c.i.	C-0.3221	R-3.1 c.i.	C-0.6083	R-1.8 c.i.
Floors						
Mass	U-0.194	R-4.8 c.i.	U-0.1943	R-4.8 c.i.	U-0.327	R-2.6 c.i.
Steel joist	U-0.164	R-8.6	U-0.164	R-8.6	U-0.266	R-5.3
Wood framed and other	U-0.138	R-6.7+ R-1.3 c.i.	U-0.138	R-6.7+ R-1.3 c.i.	U-0.169	R-6.7
Slab-on-grade floors						
Unheated	F-2.219	R-2.6 full slab	F-2.167	R-2.6 full slab	F-2.7605	R-3.5 for 1200 mm
Heated	F-3.430	R-2.6 full slab	F-1.9068	R-4.4 full slab	F-4.396	R-3.5 for 1200 mm
Opaque doors						
Swinging	U-2.556		U-2.556		U-2.556	
Nonswinging	U-2.556		U-2.556		U-2.556	

Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. VT/*SHGC***
Vertical fenestration, 0% to 40% of *wall*		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.64	S-0.45 E&W-0.41 N-0.55	1.10	U-1.64	S-0.45 E&W-0.41 N-0.55	1.10	U-1.64	NR	NR
Metal framing, fixed	U-1.94			U-1.94			U-1.94		
Metal framing, operable	U-2.04			U-2.04			U-2.25		
Metal framing, entrance door	U-3.94			U-3.48			U-3.94		
Skylight, 0% to 3% of *roof*									
All types	U-2.84	NR	NR	U-2.84	NR	NR	U-4.83	NR	NR

* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1-2013, Section 3.2), FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.5), *Ls = liner system* (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2.4), NR = no (insulation) requirement.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1-2013, Section A2.3.2).

(This appendix 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.)

INFORMATIVE APPENDIX F
INTEGRATED DESIGN

F1. *INTEGRATED DESIGN PROCESS*/INTEGRATED PROJECT DELIVERY

Integrated design, and related concepts such as *integrated project delivery* and integrative design, requires early stakeholder collaboration to enable stronger, more balanced design solutions in all aspects of a project through the sharing of knowledge and expertise among project team members. This *integrated design process* is in contrast to traditional methods, where there is a limited utilization of the skills and knowledge of all stakeholders in the development of design solutions. An *integrated design process* enables the construction of *high-performance green buildings* that consume fewer resources and achieve better comfort and functionality. A goal of integrated processes is to better enable the construction of *high-performance green buildings* that consume fewer resources and achieve better comfort and functionality, as well as increased predictability of project outcomes early on.

Integrated design facilitates higher building performance by bringing major issues and key participants into the project early in the design process. For the most part, the opportunities for creatively addressing solutions occur very early in the design process. The complex interactions of sophisticated building systems require early coordination in order to maximize effectiveness and output of such systems. Early team building and goal setting may also reduce total project costs. This collaborative process can inform building form envelope and mechanical, electrical, plumbing and other systems. The later in the design process that systems are introduced to the project, the more expensive the implementation of such systems will be. Use of building information technologies can also be a valuable asset in increasing predictability of outcomes earlier in the project and is recommended for all integrated teams.

An iterative design process is intended to take full advantage of the collective knowledge and skills of the design team. A linear process approaches each problem sequentially. In contrast, an integrated process approaches each problem with input from the different viewpoints of the participants and the issues they represent, circling back after each design decision to collectively evaluate the impact on all stakeholders. This process acknowledges the complex interdependency of all building systems and their relationship to resource consumption and occupant well being.

There are several existing, and currently evolving, models for collaboration which can be considered: for example, *ASHRAE Handbook—HVAC Applications*, Chapter 57; the MTS 1.0 WSIP Guide, *Whole Systems Integrated Process Guide for Sustainable Buildings and Communities*; and *Integrated Project Delivery: A Guide* by the AIA and AIA California Council.

Project specific integrated design and/or *integrated project delivery* processes should be determined with full participation of the stakeholder team. What works for one project may not prove the best approach for the next. Additionally, the team should collectively identify the performance standards and the associated metrics by which the project success will be judged. Design charrettes of varying duration may be an effective tool to consider, though ultimately it is the responsibility of the stakeholder team to determine the process that will best fit any specific problem or project.

F1.1 Design Charrette. The following outlines one type of design charrette process that has resulted in successful integrated design.

At the initial stages of building design, a charrette process can be initiated and the members of the process should include all the stakeholders.

F1.1.1 Charrette Process. Experienced personnel representing each specialty should participate in the charrette process. A discussion of all the systems and all the items that affect the *integrated design* should be discussed. Stakeholders should be able to decide and vote on the best integrated system.

The integrative team process should entail the following steps of design optimization:

a. The original goals and budget of the project should be revisited to see whether the overall intentions of the project are intact.
b. The project should be compared against this standard or at least one existing green rating system.
c. Each of the building and *site* components should be scrutinized to help ensure natural systems for energy conservation, lighting, ventilation, and passive heating and cooling are maximized before mechanical systems are engaged.
d. The appropriateness and integration logic of the building's primary systems should be confirmed.
e. The impact of the design on the *site* and its larger context should be evaluated, including the environmental impact on a life-cycle cost basis.
f. Building information modeling (BIM) software, design tools, and the experience of the design team should be used if practical to help optimize the design.
g. All members of the design team should be included when making design decisions.
h. Commissioning and consideration of future operation and maintenance (O&M) requirements should be included within the design optimization process.

F1.1.2 Design Charrette Matrix. At the end of the charrette process, a matrix for each proposed building scheme can be developed and evaluated to summarize the impact on the *site*, water, energy, materials, and indoor environmental quality and to help lead to a decision as to the best integrated system. The matrix contains cells indicating the high-performance value, grading a particular building system to its appropriate high-performance criteria. Each high-perfor-

mance value is qualitatively rated from 1 to 10, with 1 being the lowest (minimal energy savings, low air quality, low water efficiency, high cost) and 10 being the highest (high energy savings, high air quality, high water efficiency, low cost). The average of the high-performance values for each building system is the aggregate index. Selection of the best system should be based upon a comparison of these aggregate indices for each matrix.

Scheme #1—with Atrium, maximum exposure on the south, three-story office building.

	High-Performance Criteria						
Building System	***Site***	**IAQ**	**IEQ**	**Energy**	**Comm. M&V**	**Initial Cost**	**O & M**
Arch	8	7	6	1	6	1	6
HVAC	—	5	6	2	6	2	7
Plumbing	NA	—	—	—	—	2	7
Structural	—	—	—	—	—	2	
Aggregate index	8	6	6	1.5	6	2	6.8

Result:
Least numbers under energy and cost column defines consumption of substantial energy with high initial cost.

Scheme #2—without Atrium, three-story, minimum exposure on the south and west side.

	High-Performance Criteria						
Building System	***Site***	**IAQ**	**IEQ**	**Energy**	**Comm. M&V**	**Initial Cost**	**O & M**
Arch	6	7	7	7	7	7	6
HVAC	NA	5	7	7	7	7	7
Plumbing	NA	—	—	—	7	7	7
Structural	—	—	—	—	—		
Aggregate index	6	6	7	7	7	7	6.8

Result:
High numbers on all columns indicate the building is conceived optimally.

FIGURE F-1 Sample charrette design matrices.

(This appendix 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.)

INFORMATIVE APPENDIX G
INFORMATIVE REFERENCES

This appendix contains informative references for the convenience of users of this standard and to acknowledge source documents when appropriate. Section numbers indicate where the reference occurs in this document.

Reference	Title	Section
American Institute of Architects (AIA) 1735 New York Avenue NW Washington, DC 20006, United States 1-800-AIA-3837 or 202-626-7300; www.aia.org		
AIA National/AIA California Council	Integrated Project Delivery: A Guide, v. 1-2007	Appendix H
American Institute of Steel Construction One East Wacker Drive, Suite 700 Chicago, Illinois 60601, United States 1-312-670-2400; www.aisc.org		
Brochure	Steel Takes LEED® with Recycled Content	9.4.1.1
ASHRAE 1791 Tullie Circle NE Atlanta, GA 30329, United States 1-404-636-8400; www.ashrae.org		
ASHRAE Guideline 0-2005	The Commissioning Process	10.3.1.1
ASHRAE Guideline 1.1-2007	HVAC&R Technical Requirements to Support the Commissioning Process	10.3.1.1
ASHRAE Guideline 4-2008	Preparation of Operating and Maintenance Documentation for Building Systems	10.3.1.1
ASHRAE Standard 62.1-2013 (with Appendix B)	Ventilation for Acceptable Indoor Air Quality	Table 10.3.1.4
ASHRAE Handbook, 2013	Fundamentals	Appendix D
ASHRAE Handbook, 2011	HVAC Applications	Appendix H
Association of Pedestrian and Bicycle Professionals PO Box 93 Cedarburg, WI 53012, United States 1-262-375-6180; www.apbp.org		
	Bicycle Parking Guidelines, 2nd Edition, 2010	5.3.5.2
ASTM International 100 Barr Harbor Dr. West Conshohocken, PA 19428-2959, United States 1-610-832-9585; www.astm.org		
ASTM C755-10	Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation, Appendix X1 Problem Analysis	8.3.6
ASTM E1331 - 09	Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry	8.4.1.2
ASTM E1477 - 98a(2008)	Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers	8.4.1.2
ASTM E2813-12	Standard Practice for Building Enclosure Commissioning	10.3.1.2.5
British Standards Institute 389 Chiswick High Road London, W4 4AL, United Kingdom +44 845 086 9001 www.bsigroup.com		
BS 8493:2008	Light reflectance value (LRV) of a surface. Method of test.	8.4.1.2

Reference	Title	Section
California Environmental Protection Agency, Office of Environmental Health Hazard Assessment Post Office Box 4010 Sacramento, CA 95812-4010, United States 1-916-324-7572; www.oehha.ca.gov		
http://www.oehha.org/air/allrels.html	Air Toxics Hot Spots Program Risk Assessment Guidelines. Technical Support Document for the Derivation of Noncancer Reference Exposure Levels	8.4.2, 8.5.2
Canadian Standards Association (CSA) 5060 Spectrum Way, Suite 100 Mississauga, Ontario, L4W 5N6, Canada 1-800-463-6727 and 1-416-747-4000; www.csa.ca		
CSA S478-95 (R2007)	Guideline on Durability for Buildings	9.4.1, 10.3.2.3
Carpet and Rug Institute 730 College Drive Dalton, Georgia 30720, United States 1-706-278-3176; www.carpet-rug.org		
		8.4.2.3
Cool Roof Rating Council 1610 Harrison Street Oakland, California 94612, United States 1-510-482-4421; www.coolroofs.org		
CCRC-1-2008	Cool Roof Council Product Rating Program	5.3.2.4
Forest Stewardship Council (FSC) 1155 30th Street NW, Suite 300 Washington, DC 20007, United States 1-202-342-0413; www.fsc.org		
		9.4.1.3.1
Illuminating Engineering Society of North America, 120 Wall Street, Floor 17 New York, NY 10005-4001 1-212-248-5017, www.ies.org		
IDA/IES Model Lighting Ordinance	Model Lighting Ordinance (MLO)	5.3.3.2
Institute of Transportation Engineers 1099 14th Street NW, Suite 300 West Washington, DC 20005-3438, United States 1-202-289-0222; www.ite.org		
4th Edition, 2004	Parking Generation	10.3.2.4
Market Transformation to Sustainability (MTS) 1511 Wisconsin Avenue, N.W. Washington, D.C. 20007, United States 1-202-338-3131; www.sustainableproducts.com		
MTS 1.0 WSIP Guide-2007	Whole Systems Integrated Process Guide for Sustainable Buildings and Communities	Appendix H
National Institute of Building Sciences (NIBS) 1090 Vermont Avenue, NW, Suite 700 Washington, DC 20005-4905, United States 1-202-289-7800; www.nibs.org		
NIBS Guideline 3-2012	Building Enclosure Commissioning Process BECx	10.3.1.2.5
National Renewable Energy Laboratory (NREL) 1617 Cole Blvd. Golden, CO 80401-3393, United States 1-303-275-3000; www.nrel.gov		
NREL/TP-550-38617	Source Energy and Emissions Factors for Energy Use in Buildings	Table 7.5.3

Reference	Title	Section
Resilient Floor Covering Institute **115 Broad Street, Suite 201** **LaGrange, GA 30240, United States** **1-706-882-3833; www.rfci.com**		
		8.4.2.3
Sheet Metal and Air Conditioning Contractors National Association (SMACNA) **4201 Lafayette Center Drive** **Chantilly, VA 20151, Unites States** **1-703-803-2980**		
ANSI/SMACNA 008-2008	IAQ Guidelines for Occupied Buildings under Construction	10.3.1.4(a)
State of California, Department of General Services, Procurement Division **Ziggurat Building** **707 Third Street** **West Sacramento, CA 95605-2811, United States** **1-916-376-5000**		
RFP DGS-56275	Section 5.7, "Indoor Air Quality Requirements for Open Office Panel Systems"	Appendix E
Steel Recycling Institute **680 Andersen Drive** **Pittsburgh, PA 15220, United States** **1-412-922-2772; www.recycle-steel.org**		
Brochure	Steel Takes LEED® With Recycled Content	9.4.1.1
Sustainable Forestry Initiative, Inc. (SFI) **1600 Wilson Blvd, Suite 810** **Arlington, VA 22209, United States** **1-703-875-9500; www.sfiprogram.org**		
		9.4.1.3.1
UL GREENGUARD Gold **2211 Newmarket Parkway, #110** **Marietta, GA 30067, United States** **1-800-427-9681; www.ul.com/environment**		
		8.4.2, 8.5.2
United States Department of Health and Human Services **Agency for Toxic Substances and Disease Registry (ATSDR)** **4770 Buford Hwy NE** **Atlanta, GA 30341, United States** **1-800-232-4636; www.atsdr.cdc.gov**		
www.atsdr.cdc.gov/mrls	Minimal Risk Levels (MRLs)	Table 10.3.1.4
United States Department of Energy (DOE) **Washington, DC 20585, United States** **1-202-586-5000; www.energyplus.gov**		
	EnergyPlus (or predecessors BLAST or DOE-2)	Appendix D
United States Environmental Protection Agency (EPA) **1200 Pennsylvania Ave NW** **Washington, DC 20460, United States** **1-888-782-7937 and 1- 202-775-6650; www.energystar.gov**		
	Portfolio Manager	10.3.2.1.3.2
United States General Services Administration (GSA) **1800 F Street, NW** **Washington, DC 20405, United States** **1-800-488-3111 and 1-202-501-1100; www.gsa.gov**		
U.S. GSA-2005	The Building Commissioning Guide	10.3.1

(This appendix 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.)

INFORMATIVE APPENDIX H
ADDENDA DESCRIPTION INFORMATION

ANSI/ASHRAE/USGBC/IES Standard 189.1-2014 incorporates ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 and Addenda a, b, c, d, e, f, h, j, k, l, m, n, o, q, r, s, t, u, v, w, x, y, z, aa, ab, ac, ad, ae, af, ag, ah, aj, al, an, ao, ap, aq, as, at, au, av, aw, ax, ay, bb, bc, bd, bf, bh, bi, bj, bk, bm, bn, bo, bp, bq, br, bs, bt, bu, bv, bw, bx, bz, cb, and cd to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011. Table H-1 lists each addendum and describes the way in which the standard is affected by the change. It also lists the ASHRAE, and ANSI approval dates for each addendum.

TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
a	Section 8.4.2, Section 11, and Appendix E	This addendum updates references to the newly approved ANSI/BIFMA M7.1-2011, ANSI/BIFMA X7.1-2011, and ANSI/BIFMA e3-2011 in Sections 8 and 11. It deletes all of Appendix E, making reference to the relevant material in Section 8.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
b	Sections 8.3.1.5, 8.3.1.5.1, and 8.3.1.5.2	This addendum addresses situations in which the requirement for a three-surface entry mat system is not warranted based on limited traffic at the entrance.	June 26, 2013	June 28, 2013	June 30, 2013	July 24, 2013
c	Section 5.3.3	This addendum narrows the scope of the reference to Standard 90.1 to just those sections involved with exterior lighting.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
d	Section 5.3.1	This addendum clarifies the intent of this exception to relax the limitations of 150 ft and 100 ft for the case of low-impact trails.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
e	Section 7.4.7 and Section 11	This addendum updates Standard 189.1-2011 references to Energy Star.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
f	Appendix D	This addendum updates the modeling requirements for on-site renewable energy systems in Normative Appendix D. The addendum changes the requirements for modeling both the baseline and proposed buildings.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
h	Sections 3.2, 7.3, 7.4, and 10.3.1	This addendum clarifies the requirements for a continuous air barrier in Section 7 of the standard, as well as the requirements for airtightness commissioning in Section 10.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Jan. 30, 2013
j	Section 5.3.2	This addendum clarifies shading provided by vegetation for the site hardscape and walls for heat island mitigation (Sections 5.3.2.1 and 5.3.2.2).	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Feb. 28, 2013

*These descriptions may not be complete and are provided for information only.

TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
k	Sections 3.2 and 7.4.3.7, Appendix D	This addendum updates Section 7.4.3.7, which was written to reference the language in ASHRAE/ANSI/IES Standard 90.1-2007.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Feb. 28, 2013
l	Sections 3.2 and 7.4.3.1, Appendix C	This addendum recommends the inclusion into ASHRAE Standard 189.1 of a new Table C-17 that contains the minimum efficiencies of transformers for buildings that are following Path B of Section 7.4.3.1(b)—i.e., those buildings that have a lower amount of on-site renewable generation and have required minimum efficiencies greater than the minimum federal efficiencies.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Jan. 30, 2013
m	Sections 3.2, 8.1, and 8.3.6	This addendum adds lighting quality to the scope of Section 8 and some initial requirements related to controls, recognizing that good lighting quality supports occupant satisfaction consistent with the goals of high-performance buildings.	Jan. 18, 2014	Jan. 3, 2014	Jan. 22, 2014	Jan. 23, 2014
n	Section 5.3.2 and Appendix D	This addendum clarifies the heat island reduction provisions in Sections 5.3.2.3 and 5.3.2.4 to include aged values for solar reflective index and to include a reference to the Cool Roof Rating Council ANSI standard. It also modifies the solar reflectance and emittance values in Normative Appendix D. The attached document is "as modified" during committee discussions.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
o	Section 9.3.5	This addendum adds a new mandatory provision establishing maximum mercury content levels for certain types of electric lamps	Jan. 18, 2014	Jan. 3, 2014	Jan. 22, 2014	Jan. 23, 2014
q	Section 10.3.1.2	This addendum clarifies that systems that require commissioning also include commissioning of the associated control systems.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Jan. 30, 2013
r	Section 8.3.1	This addendum adds references to ANSI/ASHRAE 170-2008, recognizing that such facilities are not covered by ANSI/ASHRAE Standard 62.1.	June 26, 2013	June 28, 2013	June 30, 2013	July 1, 2013
s	Sections 8.3.1.2 and 10.3.2	This addendum clarifies the requirements for outdoor airflow monitoring in Section 8, along with operational requirements for such monitoring in Section 10.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Jan. 30, 2013
t	Section 4	This addendum clarifies the role of standards referenced by Standard 189.1 and addresses situations in which the requirements of two or more referenced standards, both of which are required for compliance with Standard 189.1, may have inconsistent requirements.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
u	Sections 3.2, 5.3.2, 5.3.3, 5.3.4, 5.3.5, and 5.4	This addendum strengthens the standard's storm water management requirements and makes all the site requirements mandatory, removing the prescriptive or performance options.	June 26, 2013	June 28, 2013	June 30, 2013	July 24, 2013

*These descriptions may not be complete and are provided for information only.

TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
v	Sections 3.2, 6.3.2.1, 6.3.2.2, and 6.3.2.4	This addendum increases the water use stringency for toilets, clothes washers, dishwashers, and green roofs.	June 28, 2014	July 9, 2014	July 2, 2014	July 31, 2014
w	Sections 3.2 and 5.3.5.2	This addendum provides bicycle parking design requirements.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
x	Section 5.3.3	This addendum modifies the backlight, uplight and glare (BUG) threshold values to match those found in the latest draft of the IDA/IES Model Lighting Ordinance.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
y	Sections 7.4.1, 7.4.3, 7.4.4, and 7.4.5; Appendix D	This addendum clarifies the requirements for heating, ventilating, air conditioning, and service water heating equipment when compliance path is chosen for the building project where federal minimum preemptive efficiency requirements are applicable.	Jan. 26, 2013	Jan. 24, 2013	Jan. 29, 2013	Feb. 28, 2013
z	Appendix C	This addendum adds a new Table B-14 to Appendix B.	June 26, 2013	June 28, 2013	June 30, 2013	July 1, 2013
aa	Sections 8.3.4, 8.4.1, and 8.5.1; Appendix D	This addendum provides more flexibility in achieving minimum daylight requirements, allows for the alternative of using the performance path to show equivalent daylighting benefits, and adds occupancy exceptions to the requirement for diffusing glazing.	June 23, 2012	June 18, 2012	June 27, 2012	June 28, 2012
ab	Section 9.4.1.1	This addendum allows salvaged material content to be added to the recycled content requirement of Section 9.4.1.	Jan. 21, 2012	Jan. 17, 2012	Jan. 25, 2012	Jan. 26, 2012
ac	Section 7.4.7	This addendum deletes the Energy Star requirements and requires compliance with the NEMA standard in residential spaces.	Jan. 21, 2012	Jan. 17, 2012	Jan. 25, 2012	Jan. 26, 2012
ad	Section 10.3.2.1.1	This addendum adds new language requiring a plan for the formal maintenance of roof vegetation used to comply with requirements to mitigate heat island effects.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
ae	Sections 8.4.2.1.1, 8.4.2.1.2, 8.4.2.2, and 8.4.2.2.2; Section 11	This addendum updates several referenced standards and allows the California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings (SCM) as an alternative compliance path to SCAQMD Rule 1113 for the VOC content requirements of paints and coatings.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
af	Section 7.4.7.1 and Appendix C	This addendum removes the motor efficiencies within the standard, citing minimum motor efficiencies included in ANSI/ASHRAE/IES Standard 90.1-2010.	June 26, 2013	June 28, 2013	June 30, 2013	Jan. 23, 2014
ag	Section 3.2	This addendum updates definitions related to daylighting by referencing ANSI/ASHRAE/IES Standard 90.1-2010.	June 26, 2013	June 28, 2013	June 30, 2013	Jan. 23, 2014
ah	Sections 3.2 and 9.3.4	This addendum adds a definition of electronics and clarifies the requirements for areas for storing and collecting recyclables, including areas for batteries and electronics.	June 26, 2013	June 28, 2013	June 30, 2013	Jan. 23, 2014

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TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
aj	Sections 3.2 and 5.3.5	This addendum adds new requirements for preferred parking for low emission, hybrid, and electric vehicles.	August 1, 2014	August 6, 2014	August 4, 2014	August 7, 2014
al	Section 7.4.2 and Appendix A	This addendum makes the requirements for opaque wall assemblies in Climate Zones 1 through 3 consistent with ANSI/ASHRAE/IES Standard 90.1-2013 and increases the referenced requirements by a percentage in Climate Zones 4 through 8.	June 28, 2014	July 9, 2014	July 2, 2014	July 31, 2014
an	Table 7.5.3	This addendum makes changes to Table 7.5.3, which contains equivalent carbon dioxide emission rates (CO_2e) for common energy sources used in buildings.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
ao	Section 8.3.1.3	This addendum clarifies the requirements for sealing particulate filters and air cleaners.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
ap	Sections 3.2 and 8.4.1.1	This addendum harmonizes the requirements for sidelighting apertures with those in ANSI/ASHRAE/IES Standard 90.1.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
aq	Sections 3.2 and 9.3.1	This addendum clarifies and adds requirements for construction waste management strategies and techniques that count as diversion.	August 1, 2014	August 6, 2014	August 4, 2014	August 7, 2014
as	Sections 7.4.1.1, 7.4.3, 7.4.4, and 7.4.7; Appendix A	This addendum clarifies that Normative Appendix B (prescriptive equipment efficiency tables) applies only to the prescriptive compliance path with lower levels of on-site renewables and higher efficiency equipment, designating it as the alternate renewables approach.	June 28, 2014	July 9, 2014	July 2, 2014	July 31, 2014
at	Sections 3.2, 7.4.3.9, and 8.3.1.6	This addendum adds more significant thermostat setups and setbacks, as well as a ventilation shut-off, to unrented hotel guestrooms; it also adds more clarity to the existing guestroom requirements.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
au	Section 7.4.6.6	This addendum replaces the ANSI/ASHRAE/IES Standard 90.1 control requirements for parking lot lighting with three control requirements for parking lot lighting.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
av	Sections 7.4.6.2 and 7.4.6.4	This addendum updates control requirements to be compatible with ANSI/ ASHRAE/IES Standard 90.1.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
aw	Sections 9.4.1 and 9.4.1.4	This addendum increases the range of products and materials that are considered and introduces more holistic considerations of supply chain impacts of products via life-cycle assessment (LCA).	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
ax	Sections 7.4.6.1, 7.4.6.1.1, and 7.4.6.1.2	This addendum updates the format of the space-by-space lighting power density factor table, while maintaining the current level of stringency relative to ANSI/ ASHRAE/IES Standard 90.1.	August 1, 2014	August 6, 2014	August 4, 2014	August 7, 2014

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TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
ay	Sections 3.2 and 7.4.3.2	This addendum modifies the demand control ventilation (DCV) requirements to make them more compatible with recent changes to the DCV requirements in ANSI/ASHRAE/IES Standard 90.1.	August 1, 2014	August 6, 2014	August 4, 2014	August 26, 2014
bb	Sections 3.2 and 7.4.2.7	This addendum adds a new section to modify the U-factor requirements for high-speed doors that open and close quickly compared to traditional doors.	June 28, 2014	July 9, 2014	July 2, 2014	July 3, 2014
bc	Sections 3.2 and 7.4.7.3	This addendum revises the Energy Star lighting requirements and updates the normative and informative references to more recent versions.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bd	Section 7.4.2.8	This addendum simplifies the requirements for building and fenestration orientation and aligns them with the format and requirements of ANSI/ASHRAE/IES Standard 90.1.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bf	Section 7.5.4	This addendum deletes the criterion for peak electricity use based on changes in the modeling rules for the fuel source of the baseline building.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bh	Section 5.3.3	This addendum adds a new section requiring identification of plants that tend to benefit the local ecosystem (i.e., native plants) and plants that are detrimental to the local ecosystem (i.e. invasive plants).	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bi	Appendix D	This addendum updates Appendix C, which contains the modeling rules for the performance option for energy efficiency, to incorporate changes made to Appendix G in ANSI/ASHRAE/IES Standard 90.1.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bj	Sections 3.2, 7.5.1, 7.5.2, and 7.5.3	This addendum creates two optional performance paths for compliance with the energy requirements within this standard, both of which contain criteria for both whole-building total energy cost and equivalent carbon dioxide emissions (CO2e).	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bk	Section 7.4.3.5	This addendum adds a fan-efficiency requirement in Standard 189.1 that is slightly more stringent than the requirements in ANSI/ASHRAE/IES 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bm	Sections 3.2 and 9.4.1	This addendum adds more building components and clarifies salvaged material requirements.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bn	Section 8.3.1.7	This addendum adds a requirement for an automated preoccupancy outdoor air purge in order to ameliorate indoor contaminant buildup that may occur during extended periods of time during which ventilation systems are off.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bo	Appendix C	This addendum updates the requirements for economizers to reflect requirements in ANSI/ASHRAE/IES 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014

*These descriptions may not be complete and are provided for information only.

TABLE H-1 Addenda to ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 *(Continued)*

Addendum	Section(s) Affected	Description of Changes*	ASHRAE Standards Committee Approval	Cosponsor Approval	ASHRAE BOD Approval	ANSI Approval
bp	Appendix C	This addendum revises language in the exhaust air energy recovery section to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bq	Appendix C	This addendum updates the efficiency requirements for electrically operated unitary air conditioners and condensing units to reflect requirements in ANSI/ ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
br	Appendix C	This addendum updates the requirements for air- and water-cooled chillers to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bs	Appendix C	This addendum revises requirements for single-packaged vertical air conditioners, single-packaged vertical heat pumps, room air conditioners, and room air conditioner heat pumps to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bt	Appendix C	This addendum updates requirements for gas- and oil-fired Boilers to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bu	Appendix C	This addendum updates requirements for water-heating equipment to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bv	Appendix C	This addendum adds new requirements for variable refrigerant flow (VRF) air conditioners and heat pumps to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	August 1, 2014	August 6, 2014	August 4, 2014	August 7, 2014
bw	Appendix C	This addendum proposes to update the performance requirements for heat rejection equipment to remain current with industry trends as well as to reflect requirements in ANSI/ASHRAE/IES Standard 90.1-2013.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
bx	Section 8.3.6	This addendum revises the existing requirements for addressing moisture in building envelopes to be more stringent and to use largely performance-based design criteria.	August 1, 2014	August 6, 2014	August 4, 2014	August 26, 2014
bz	Section 10.3.1.6	This addendum replaces an existing requirements in the standard to address outdoor air quality impacts of construction vehicles with a requirement that limits vehicle idling and requires signage.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
cb	Appendix D	This addendum modifies the fenestration orientation requirements in Table D1.1.	June 28, 2014	July 9, 2014	July 2, 2014	July 10, 2014
cd	Sections 3.2 and 10.3.1.7	This addendum adds measures to reduce the entry of contaminants from occupied spaces within the construction area or those that are immediately adjacent.	August 1, 2014	August 6, 2014	August 4, 2014	August 7, 2014

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NOTICE

INSTRUCTIONS FOR SUBMITTING A PROPOSED CHANGE TO THIS STANDARD UNDER CONTINUOUS MAINTENANCE

This standard is maintained under continuous maintenance procedures 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. SSPC consideration will be given to proposed changes within 13 months of receipt by the manager of standards (MOS).

Proposed changes must be submitted to the MOS in the latest published format available from the MOS. However, the MOS may accept proposed changes in an earlier published format if the MOS concludes that the differences are immaterial to the proposed change submittal. If the MOS concludes that a current form must be utilized, the proposer may be given up to 20 additional days to resubmit the proposed changes in the current format.

ELECTRONIC PREPARATION/SUBMISSION OF FORM FOR PROPOSING CHANGES

An electronic version of each change, which must comply with the instructions in the Notice and the Form, is the preferred form of submittal to ASHRAE Headquarters at the address shown below. The electronic format facilitates both paper-based and computer-based processing. Submittal in paper form is acceptable. The following instructions apply to change proposals submitted in electronic form.

Use the appropriate file format for your word processor and save the file in either a recent version of Microsoft Word (preferred) or another commonly used word-processing program. Please save each change proposal file with a different name (for example, "prop01.doc," "prop02.doc," etc.). If supplemental background documents to support changes submitted are included, it is preferred that they also be in electronic form as word-processed or scanned documents.

For files submitted attached to an e-mail, ASHRAE will accept an electronic signature (as a picture; *.tif, or *.wpg) on the change submittal form as equivalent to the signature required on the change submittal form to convey non-exclusive copyright.

Submit an e-mail containing the change proposal files to:
change.proposal@ashrae.org

Alternatively, mail paper versions to:
ASHRAE
Manager of Standards
1791 Tullie Circle, NE
Atlanta, GA 30329-2305

Or fax them to:
Attn: Manager of Standards
404-321-5478

The form and instructions for electronic submittal may be obtained from the Standards section of ASHRAE's Home Page, www.ashrae.org, or by contacting a Standards Secretary via phone (404-636-8400), fax (404-321-5478), e-mail (standards.section@ashrae.org), or mail (1791 Tullie Circle, NE, Atlanta, GA 30329-2305).

FORM FOR SUBMITTAL OF PROPOSED CHANGE TO AN ASHRAE STANDARD UNDER CONTINUOUS MAINTENANCE

NOTE: Use a separate form for each comment. Submittals (Microsoft Word preferred) may be attached to e-mail (preferred), or submitted in paper by mail or fax to ASHRAE, Manager of Standards, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: change.proposal@ashrae.org. Fax: +1-404/321-5478.

1. Submitter:

Affiliation:

Address: City: State: Zip: Country:

Telephone: Fax: E-Mail:

I hereby grant ASHRAE the non-exclusive royalty rights, including non-exclusive rights in copyright, in my proposals. I understand that I acquire no rights in publication of the standard in which my proposals in this or other analogous form is used. I hereby attest that I have the authority and am empowered to grant this copyright release.

Submitter's signature: _____ Date: _____

All electronic submittals must have the following statement completed:

I *(insert name)* _____, through this electronic signature, hereby grant ASHRAE the non-exclusive royalty rights, including non-exclusive rights in copyright, in my proposals. I understand that I acquire no rights in publication of the standard in which my proposals in this or other analogous form is used. I hereby attest that I have the authority and am empowered to grant this copyright release.

2. Number and year of standard:

3. Page number and clause (section), subclause, or paragraph number:

4. I propose to: *(check one)*

[ ] Change to read as follows
[ ] Add new text as follows
[ ] Delete and substitute as follows
[ ] Delete without substitution

Use underscores to show material to be added (<u>added</u>) and strike through material to be deleted (~~deleted~~). Use additional pages if needed.

5. Proposed change:

6. Reason and substantiation:

7. Will the proposed change increase the cost of engineering or construction? If yes, provide a brief explanation as to why the increase is justified.

[ ] Check if additional pages are attached. Number of additional pages: _____

[ ] Check if attachments or referenced materials cited in this proposal accompany this proposed change. Please verify that all attachments and references are relevant, current, and clearly labeled to avoid processing and review delays. *Please list your attachments here:*

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

ASHRAE · 1791 Tullie Circle NE · Atlanta, GA 30329 · www.ashrae.org

About ASHRAE

ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its members focus on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability. Through research, standards writing, publishing, certification and continuing education, ASHRAE shapes tomorrow's built environment today.

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IMPORTANT NOTICES ABOUT THIS STANDARD

To ensure that you have all of the approved addenda, errata, and interpretations for this standard, visit www.ashrae.org/standards to download them free of charge.

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