STANDARD

ANSI/ASHRAE/IES Standard 100-2015
(Supersedes ANSI/ASHRAE/IESNA Standard 100-2006)

Energy Efficiency in Existing Buildings

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c. offering constructive criticism for improving the Standard, or
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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

This revision of ANSI/ASHRAE/IES Standard 100-2006 provides greater guidance and a more comprehensive approach to the retrofit of existing buildings for increased energy efficiency, and also brings the standard in line with other published ASHRAE documents, specifically ANSI/ASHRAE/IES Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings*, and the 2011* ASHRAE Handbook—HVAC Applications*.*

The revised standard provides comprehensive and detailed descriptions of the processes and procedures for the retrofit of existing residential and commercial buildings in order to achieve greater measured energy efficiency. The standard addresses major and minor modifications for both residential and commercial buildings. It addresses single and multiple activity buildings with variable occupancy periods (one shift, two shift, three shift) and it identifies the approach for 53 building types (per CBECS and RECS) in 17 climate zones/subzones. At the same time, it identifies requirements for buildings with energy targets undergoing major retrofit and for buildings without energy targets (mostly industrial, agricultural, and special laboratories) and provides multiple levels of compliance. The standard is not intended to be a rating system, such as those defined by ASHRAE or EPA. This standard directly addresses a building's energy-use efficiency in a quantitative manner and provides a means to improve that efficiency with an objective benchmark.

Included in the revised standards are criteria for energy-use surveys and auditing and requirements related to implementation and verification. Appendices are included for life-cycle cost analysis procedures as well as identification of potential energy conservation measures.

Recognizing that the actual occupancy of the building plays a key role in its performance, the standard establishes the need for development of an energy management plan and an operation and maintenance program. It also addresses the requirements for ongoing commissioning.

The standard takes advantage of the fact that any building that has been in operation for at least twelve months can quickly determine its performance relative to some benchmark, which is defined in the standard as an energy-use intensity target. This concept is the new paradigm for energy-conscious design, construction, and operation of buildings.

1. PURPOSE

1.1 This standard provides criteria that will result in energy efficiency in existing buildings.

1.2 This standard is directed toward providing procedures and programs essential to energy efficient operation, maintenance, management, and monitoring; increasing the energy efficiency of the energy-using systems and components; and upgrading the thermal performance of the building envelope.

2. SCOPE

This standard applies to existing buildings, portions of buildings, and building complexes, including the envelope and all systems in the building. This standard excludes industrial and agricultural processes in buildings for which the energy targets do not include those processes.

3. DEFINITIONS

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 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.

analog control: a control loop in which data is expressed or measured by means of one or more physical properties that can express any value along a continuous scale. All types of control systems may provide analog control.

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

baseline: the first-year energy-use intensity for the building at the beginning of the compliance determination process.

binary control: a control loop in which there are only two states—for example, on-off or open-closed.

building: a structure, including mobile homes, manufactured homes, and other factory-built buildings, wholly or partially enclosed within exterior walls, or within exterior and party walls, and a roof, that affords shelter to persons, animals, or property.

building manager: the person responsible for maintaining the building, its envelope, and its energy-using systems. The building manager may also be the person responsible for expending funds on capital improvements to the building.

building operator: the person or persons who have responsibility to inspect, operate, and maintain the building systems and components that fall within the scope of this standard. The building operator may be an employee of the building owner, the building manager, or a contractor.

building owner: the holder of the property title for the building and/or the land upon which the building sits.

capital management plan: a financial plan to set aside capital to replace or upgrade building systems at the end of their useful life and/or to improve performance and energy efficiency.

complex: a group of individual or interconnected buildings on contiguous property.

conditional compliance: a compliance level between the completion of implementation in Section 9.1 and verification of compliance in Section 9.2. Conditional compliance expires 15 months following the completion of implementation.

conditioned space: a space that is provided with heating and/or cooling capable of maintaining the temperature of the space between 50°F (10°C) and 86°F (30°C)

crawl spaces: a shallow, unfinished space beneath the first floor or under the roof of a building.

daylight harvesting: the automatic control of electric light levels in response to the amount of daylight in the space.

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

dimmer: a device that varies the current through an electric light in order to control its level of illumination and energy usage.

direct digital control (DDC): a control system consisting of microprocessor-based controllers that monitor and control building systems equipment through input devices (such as sensors), output devices (such as switches and actuators), and programmed control sequences.

discounted payback: the time when the accumulated savings achieved by an investment, discounted by the appropriate discount rate, equals the initial cost of the investment. The appropriate discount rate is determined by the facility owner to reflect the owner's investment criteria.

energy accounting system: a system for measuring, collecting, and documenting the building's use of energy.

energy auditor: see *qualified energy auditor*.

energy cost: the total cost for energy supplied to a building or building site, including such charges as base charges, consumption charges, demand charges, customer charges, power factor charges, and miscellaneous charges such as sales taxes.

energy efficiency measure (EEM): an action taken in the operation or equipment in a building that reduces the energy use of the building without negative impact within the building.

energy manager (EM): the individual, identified by the building owner, who has responsibility for ensuring that energy use in the building is minimized without compromising the indoor environmental quality (building indoor air quality, thermal comfort, visual acuity and comfort, sound quality). The EM may be the building owner, a tenant, an employee of the owner or tenant, or a contractor retained by the owner or tenant.

energy-use intensity (EUI): an expression of building energy use per year in terms of net energy divided by gross floor area.

energy target (EUI_t): the net EUI (of a building) that has been established for compliance with this standard.

gross floor area for nonresidential buildings: the sum of the floor areas of all the spaces within the building with no deductions for floor penetrations other than atria. It is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings but it excludes covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, roof overhangs, parking garages, surface parking, and similar features.

gross floor area for residential buildings: the sum of the floor areas of all the conditioned (heated and/or cooled) spaces within the building, including conditioned garages, conditioned basements, and conditioned attics. It is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings. It excludes crawl spaces, covered walkways, open roofed-over areas, porches and similar spaces, exterior terraces or steps, and roof overhangs.

high-efficacy lamps: lamps with a minimum efficacy of 60 lm/W for lamps over 40 W, 50 lm/W for lamps over 15 to 40 W, or 40 lm/W for lamps 15 W or less.

HVAC system: the equipment, distribution systems, and terminals that provide the processes of heating, ventilating, or air conditioning to a building or portion of a building.

industrial process: a systematic series of mechanical or chemical operations that produce or manufacture something.

interactive effect: the change in resultant energy-savings estimates or actual energy savings due to analyzing or implementing multiple EEMs that interact with one another.

internal rate of return (IRR): the discount rate in a capital project that makes the net present value of all cash flows from a particular project equal to zero. The higher a project's IRR, the more desirable it is to undertake the project. IRR can be used to rank several prospective projects under consideration. IRR is defined by the following equation:

$$0 = \sum_{t=1}^{n} \frac{CF_t}{(1 + IRR)^t} - CF_0$$

where

n = the useful life of the measure in years

CF_t = the annual cost savings of the measure in year t (cash flow in year t)

CF_0 = the initial cost of the measure (cash flow initial)

lamp: a replaceable component of a luminaire, such as an incandescent light bulb, which is designed to produce light from electricity.

lighting schedule: a list that provides a count of all luminaires in the building, their lamps, lighting controls, fixture types, and product information.

lighting power density: the lighting power per unit area of a building or a space in a building.

luminaire: a complete lighting unit consisting of a lamp or lamps (and ballast[s] and/or driver[s] when applicable) together with the housing designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.

maintain: the process of keeping equipment and components operating or functioning in accordance with manufacturers'

recommendations and industry standards over their service lives. It involves but is not limited to carrying out observation, lubrication, adjustment, calibration, testing, cleaning, replacement, and repair at appropriate intervals as applicable to the specific equipment or component.

motion sensor: an occupancy sensor used for exterior areas.

multiscene control: a lighting control device or system that allows for two or more predefined lighting settings, in addition to an "all off" setting, for two or more groups of luminaires to suit multiple activities in the space, and allows the automatic recall of these settings.

net energy: the sum of the metered energy entering the building minus metered energy leaving the building. The same applies to portions of buildings with submetering. Bulk fuels are included using the equation in Section 5.2.2.1.

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

nonrenewable energy: energy other than renewable energy or recovered energy.

nonresidential building: as used in this standard, any building that does not match one of the types of residential buildings listed in the Table 7-1.

nontarget buildings: Buildings with activities not listed in Table 7-1 in more than 50% of the gross floor area.

occupancy sensor: a device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be regulated accordingly.

optimized bundle: A collection of EEMs that maximizes the energy savings at a facility, within the cost-effectiveness criteria of the standard. It excludes any measure with a simple payback that exceeds the life of the measure. A bundle of measures is optimized by including the maximum number of EEMs within the bundle, while still meeting the cost-effectiveness criteria. The process for determining the optimized bundle may be an iterative one, due to interactive effects of individual EEMs.

photosensor: a device that detects the presence of and/or measures the amount of visible light, infrared (IR) transmission, and/or ultraviolet (UV) energy, and emits a signal based on the presence, absence, and/or amount of these entities.

qualified commissioning authority: a person with experience commissioning at least two projects of similar size and of similar equipment to the current project, and at least one in the last three years. This experience includes the writing and execution of verification checks and functional test plans; any one of the following:

a. A licensed professional engineer in the jurisdiction where the project is located
b. A Certified CPMP (ASHRAE), a Certified Commissioning Professional (Building Commissioning Association), Certified Commissioning Authority (AABC Commissioning Group), Accredited Commissioning Process Provider (University of Wisconsin at Madison), Systems Commissioning Administrator (National Environmental Balancing Bureau), or Certified Building Commissioning Professional (Association of Energy Engineers)
c. A person qualified by the AHJ

qualified energy auditor: a person having training and expertise in building energy auditing; any one of the following:

a. A licensed professional architect or engineer in the jurisdiction where the project is located
b. An energy auditor/assessor/analyst certified by ASHRAE or AEE for all building types, or certified by BPI or RESnet for residential buildings
c. A person qualified by the AHJ

qualified person: a person having training and expertise in building energy-use analysis; any of the following:

a. A licensed professional architect or engineer, or licensed contractor in the jurisdiction where the project is located
b. Certified energy auditor or manager
c. A person qualified by the AHJ

recovered energy: energy reclaimed for useful purposes that would otherwise be wasted.

residential building: for the purposes of this standard, any building matching one of the descriptions for building types 49 through 53 in Table 7-1.

service log: a document in which service and maintenance work performed for a given piece of equipment is recorded, and that contains a date, the service technician's name, and a description of work performed.

simple payback (years): the estimated initial cost of an EEM divided by the estimated annual cost savings of the measure expressed in years. The cost savings may include energy cost savings and incremental routine operations and maintenance costs.

time switch: a device that controls lighting, equipment, or systems based on the time of day.

vacancy sensor: a sensor that automatically turns lighting, equipment, or appliances off within a specified time period after an area is vacated, which requires the lighting, equipment, or appliances to be manually turned on.

zone: a space or group of spaces within a building for which the heating, cooling, or lighting requirements are sufficiently similar that desired conditions can be maintained throughout by a single controlling device.

3.2 Abbreviations and Acronyms

AHJ	authority having jurisdiction
DDC	direct digital control
EUI	energy-use intensity
EEM	energy efficiency measure
EM	energy manager
IRR	internal rate of return
O&M	operations and maintenance

4. COMPLIANCE REQUIREMENTS

4.1 Building Type Requirements

4.1.1 Nonresidential Building

4.1.1.1 A building or complex of buildings whose majority of gross floor area has activities number 1 through 48 and/or 53 in Table 7-1 shall comply with the requirements of Sections 4.2 and 4.3.

4.1.1.2 The qualified person determining compliance shall

a. determine whether or not the building seeking compliance has an energy target (EUI_t) according to Section 7,
b. establish the energy target (EUI_t) according to Section 7,
c. complete Form B,
d. indicate on Form A if this compliance is for the whole building or for individual tenant spaces in a multitenant building, and
e. submit Forms A, B, and C to the authority having jurisdiction (AHJ).

4.1.2 Residential Building

4.1.2.1 A building with activities number 49 through 52 in Table 7-1 shall comply with the requirements of Section 10.

4.1.2.2 The qualified person determining compliance shall indicate on Form A if this compliance is for the whole building or for individual dwellings in a multidwelling building, and submit Forms A, B, and C to the AHJ.

4.1.3 Buildings with Residential and Nonresidential activities

4.1.3.1 Individual dwelling units in a multitenant building seeking compliance apart from the building shall comply with Section 10.

4.1.3.2 The qualified person determining compliance for buildings with both residential and nonresidential activities shall comply with Section 4.1.1.2.

4.2 Energy Management Plan and Operations and Maintenance Program

4.2.1 Operations and Maintenance. The building manager shall comply with the operations and maintenance requirements of Section 6. The qualified person determining compliance shall state in writing on Form A that the operating and maintenance requirements of Section 6 have been met according to the following subsections.

4.2.1.1 For first-time applicants, for the previous year.

4.2.1.2 For previously compliant buildings, since the previous validation of compliance.

4.2.2 Energy Management Plan. The building manager shall comply with the energy management requirements of Section 5. The qualified person determining compliance shall state in writing on Form A that the energy management program described in Section 5 has been developed and is being maintained as of the date on Form A.

4.3 Building Energy Use

4.3.1 Measured EUI. The qualified person shall calculate the building's measured energy-use intensity (EUI) by completing Form C according to Section 5.2.

4.3.2 Buildings with Energy Targets

4.3.2.1 Building Meets the Energy Target (EUI_t). If the building's measured EUI is less than or equal to its energy target then the building complies.

4.3.2.2 Building Does not Meet the Energy Target (EUI_t). A qualified energy auditor shall complete an energy audit according to Section 8, and EEMs that will reduce energy use to meet the energy target shall be implemented according to Section 9. Upon completion of the implementation of all required EEMs, a building shall be granted conditional compliance.

Exception: No individual requirement need be met that would compromise the historical integrity of a building or part of a building designated by a government body for long-term preservation in its existing state (for example, historical monuments).

4.3.2.3 Verification of Compliance. Within fifteen months after the completion of Section 4.3.2.2, the EUI shall be recalculated by the energy manager (EM) from 12 consecutive months of measured energy use and Form A resubmitted to the AHJ. If the building's postimplementation measured EUI is less than or equal to the energy target, then the building complies with the standard. If the building's postimplementation measured EUI is greater than the energy target, then the building does not comply with the standard, and the conditional compliance is suspended until either

a. additional EEMs have been implemented that reduce the subsequently measured EUI to below the energy target and a new Form A is submitted to the AHJ or
b. the AHJ revokes conditional compliance.

4.3.3 Buildings without Energy Targets

4.3.3.1 A qualified energy auditor shall conduct an energy audit according to Section 8, and the optimized bundle of EEMs shall be identified according to Section 9.1.1.2.

4.3.3.2 Implement EEMs. The entire optimized bundle of EEMs identified shall be implemented. Upon completion of the implementation of the optimized bundle of EEMs, a building shall be granted conditional compliance in accordance with Section 9.1.1.2.

Exception: No individual requirement need be met that would compromise the historical integrity of a building or part of a building designated by a government body for long-term preservation in its existing state (for example, historical monuments).

4.3.3.3 Verification of Compliance. If the building complies with Section 4.2, then within 15 months following the completion of implementation of the optimized bundle of EEMs, building owners with conditional compliance or the qualified person representing the building owner shall submit verification that measured postimplementation energy savings meet or exceed 75% of the energy savings projected in the energy audit report to the AHJ. Energy savings shall be compared at the whole-building consumption level in common units for electricity, fossil fuels, and other sources. If the measured postimplementation energy savings of the package of EEMs do not meet or exceed 75% of the energy savings pro-