STANDARD

ANSI/ASHRAE Standard 209-2018

Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

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c. offering constructive criticism for improving the Standard, or
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NOTE

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(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

ASHRAE Standard 209 describes a methodology to apply building energy modeling to the design process. The Standard Project Committee recognizes the important role building energy modeling plays in informing the design and operation of low-energy buildings. The standard was created to define reliable and consistent procedures that advance the use of timely energy modeling to quantify the impact of design decisions at the point in time at which they are being made. The committee believes such an approach will improve modeling effectiveness, realize greater savings, and support achieving increasingly aggressive energy savings targets.

The standard defines general modeling requirements coupled with eleven modeling cycles, each with specific modeling goals that align with distinct phases of the design, construction, or operation process. Each modeling cycle is an extension of the general modeling requirements, which represents a best-practices approach for using modeling to inform design. Seven of the modeling cycles coincide with the building design phase, three modeling cycles are applied during building construction, and one occurs postoccupancy. The postoccupancy analysis is included to help both the owner and modeler understand how modeled results compare to actual energy performance to inform operation and assumptions used in future modeling projects.

The minimum requirements of the standard can be met by completing a load-reducing modeling cycle early in the design process, as well as one additional design-phase modeling cycle. The full set of modeling cycles were developed to provide holistic modeling guidance and are included for completeness. They can be selectively adopted by organizations that desire a more robust treatment for realizing their specific project objectives. While the standard can be applied with any design process, it is best utilized when included as part of an integrative design process.

It is expected the standard will be adopted by organizations that certify high-performance buildings, as well as by utilities and agencies that provide incentives for using modeling to inform design. It can be referenced as part of a project scope of work by building owners and architects seeking an effective, uniform way to use energy modeling to achieve performance objectives.

1. PURPOSE

Define minimum requirements for providing *energy design assistance* using *building energy simulation* and analysis.

2. SCOPE

This standard applies to new buildings or major renovations of, or additions to, existing buildings using energy simulation during the design process. This standard does not apply to single-family houses, multifamily structures of three stories or fewer above grade, manufactured houses (mobile homes), or modular homes.

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.

3.2 Definitions

actual meteorological year (AMY): a data set comprising one year of historical, hourly measured or derived weather observations for a specific location.

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

balance-point temperature: the outdoor temperature at which a building's heat loss to the environment is equal to internal heat gains from people, lights, and equipment.

baseline: the building design or level of energy performance used as the basis of comparison against other *project alternatives*, usually based on a hypothetical design defined by building standards or based on the currently proposed building design at the time of *modeling cycle* analysis.

building energy simulation: building energy estimation using a computer *simulation program*.

building performance rating system: a program to assess energy and/or environmental performance of a building design. (***Informative Note:*** e.g., the Leadership in Energy and Environmental Design [LEED] program developed by the U.S. Green Building Council and the Green Globes program developed by the Green Building Initiative.)

change order: a request to modify the original scope of work after construction has begun. The need for a *change order* can include product substitutions, design changes, and differing site conditions. A request for a *change order* may be originated by the owner, a member of the design team, the contractor, or a subcontractor and typically is initiated using either a change order proposal request, a *change order* proposal, or a change directive. If approved, *change orders* permanently modify the scope of work and contract.

charrette: a meeting of project stakeholders to discuss design goals and design strategies.

comparative analysis: a modeling exercise comparing the performance of two or more design alternatives in which the important result is the relative performance of alternatives.

compliance analysis: a modeling exercise to demonstrate design compliance with energy standards or other program requirements.

construction document phase: the final portion of the design process in which detailed plans and specifications are completed.

design constraint: a condition that must be satisfied as a part of an *optimization* process in order for a design to be feasible.

design variable: a building parameter or specification that is controllable from the point of view of the designer.

energy design assistance: the process of using *energy modeling* to provide information to the owner and building design team regarding the energy performance of *project alternatives* with the intent to achieve an energy efficient design.

energy efficiency measure (EEM): an action taken in the operation of, or a change to, equipment in a building that reduces the energy use of the building while maintaining or enhancing the building's safety, comfort, and functionality.

energy end use: a component of building energy consumption due to a specific application, including but not limited to lights, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other *HVAC system* equipment (such as pumps).

energy model: a computer representation that provides information on the systems (e.g., *HVAC*, lighting, occupancy, plug loads, building envelope) that affect energy consumption in a building. The representation of the building serves, along with weather data, as the input data for a computer *simulation program*. When run, the program will simulate the energy use and demand in the described building for a time interval. Depending on the kind of program and how it is set up to run, various kinds of output may be produced.

energy modeler: an individual with primary responsibility for performance of the activities defined in this standard.

energy modeling: the process of developing an *energy model* and running a *building energy simulation*.

energy source: electricity, natural gas, fuel oil, propane, purchased heating, purchased cooling, and other building energy utility inputs.

green building concepts: measures that minimize the impact of buildings on the natural environment or that improve the indoor environment for occupants.

gross floor area: the sum of the floor areas of all the spaces within the building with no deductions for floor penetrations other than atria. *Gross floor area* 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.

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

insolation: incident or incoming solar radiation to a specific location.

life-cycle cost analysis (LCCA): an economic method for evaluating a project or *project alternatives* in which the net present value of costs arising from owning, operating, maintaining, and ultimately disposing of a project are computed for each alternative and then compared over a designated study period.

local weather station: the weather station geographically closest to the building site or having similar climate characteristics as the building site.

modeling cycle: an *energy modeling* activity with a specific purpose, applicability, and analysis approach.

optimization: an *energy modeling* aided process in which one or more *design variables* are selected and analyzed through a given test range or set of *design constraints* in order to maximize or minimize an *optimization objective* relating to one or more of the project performance goals.

optimization objective: a numerical value that is to be maximized or minimized as a part of an *optimization* process.

owner's project requirements (OPR): a written document that details the requirements of a project and the expectations for how it will be designed, constructed, and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (***Informative Note:*** The terms *project intent* or *design intent* are used interchangeably with *OPR* by some owners. See Informative Appendix D.)

process energy: energy consumed in support of a manufacturing, industrial, or commercial process other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.

process load: the load on a building resulting from the consumption or release of *process energy*.

project alternative: an energy efficiency measure, proposed *value engineering* measure, *change order* proposal, or other change to the building design or operation that impacts building energy performance and is being considered for evaluation.

schematic design: the early design phase in which fundamental elements of design, such as building form and *HVAC system* type, are typically determined.

simple box model: a simplified building representation used during the early design stage. (***Informative Note:*** See Informative Appendix C for additional information.)

simulation program: a computer program that is capable of simulating the energy performance of building systems.

site energy: energy consumed by the building as measured by the local utility and/or nonutility meters.

value engineering (VE): a process through which one or more *project alternatives* are identified that affect the cost and/or function of a building, system, or component. The typical goal is to maximize value by providing the necessary function at minimum cost. Also known as *value management*, *value methodology*, or *value analysis*.

whole-building simulation software: see *simulation program.*

3.3 Abbreviations and Acronyms

AFUE	annual fuel utilization efficiency
AHJ	authority having jurisdiction
AMY	*actual meteorological year*
BEMP	building energy modeling professional

BESA	building energy simulation analyst
bhp	brake horsepower
Btu	British thermal unit
Btu/h	British thermal unit per hour
C	Celsius
CDD	cooling degree days
cfm	cubic feet per minute
CHW	chilled water
CO	*change orders*
COP	coefficient of performance
CVRMSE	coefficient of variation of the root-mean-square error
ECI	Energy Cost Index
EEM	*energy efficiency measure*
EER	energy efficiency ratio
EF	energy factor
EUI	energy use intensity
F	Fahrenheit
ft	foot
gpm	gallons per minute
gpf	gallons per flush
h	hour
HDD	heating degree days
hp	horsepower
HSPF	heating seasonal performance factor
HVAC	heating, ventilating, and air conditioning
IEER	integrated energy efficiency ratio
I-P	inch-pound
IPLV	integrated part-load value
IMT	inverse modeling toolkit
in.	inch
LCCA	*life-cycle cost analysis*
LPD	lighting power density
NMBE	normalized mean bias error
LSG	light to solar gain
OPR	*owner's project requirements*
QA	quality assurance
QC	quality control
SEER	seasonal energy efficiency ratio
SHGC	solar heat gain coefficient
SWH	service water heating
TMY	typical meteorological year
UA	overall heat transfer coefficient × area
VE	*value engineering*
VLT	visible light transmittance
W	watt
W/ft²	watt per square foot

4. UTILIZATION

4.1 Timing of Work. The *energy modeler* shall perform *energy modeling* at each phase of the planning, design, and construction or operation of the building as specified in the *owner's project requirements* (*OPR*) or in the owner/*energy modeler* agreement and using information obtained from relevant project stakeholders, which may include the owner, design team, constructors, and operators. The modeler shall provide the results of the required simulations with opinions and recommendations, as required and appropriate for the *modeling cycle* being evaluated, in order to inform decision making by stakeholders.

4.2 Compliance

4.2.1 The building design process shall meet the requirements of

a. Section 5,
b. Section 6.3, "Modeling Cycle #3—Load Reduction Modeling," and
c. at least one of the following sections:
    1. Section 6.1, "Modeling Cycle #1—Simple Box Modeling"
    2. Section 6.2, "Modeling Cycle #2—Conceptual Design Modeling"
    3. Section 6.4, "Modeling Cycle #4—HVAC System Selection Modeling"
    4. Section 6.5, "Modeling Cycle #5—Design Refinement"
    5. Section 6.6, "Modeling Cycle #6—Design Integration and Optimization"
    6. Section 6.7, "Modeling Cycle #7—Energy Simulation Aided Value Engineering"

4.2.2 The adopting authority shall have the option of requiring additional levels of compliance:

a. Additional *modeling cycles*.
b. As-designed compliance. Meet the requirements listed in Section 4.2.1 and, additionally, the requirements in Section 7.1, "Modeling Cycle #8—As-Designed Energy Performance."
c. As-built compliance. Meet the requirements listed in Section 4.2.1 and, additionally, the requirements in Section 7.3, "Modeling Cycle #10—As-Built Energy Performance."
d. As-operated compliance. Meet the requirements listed in Section 4.2.1 and, additionally, the requirements in Section 8.1, "Modeling Cycle #11—Postoccupancy Energy Performance Comparison."

5. GENERAL REQUIREMENTS

5.1 Simulation Software Requirements. *Whole-building simulation software* used to comply with the standard shall meet the minimum requirements of ASHRAE/IES Standard 90.1 [1], Section G2.2.