STANDARD

ANSI/ASHRAE/IES Addenda af, bc, cd, and db to ANSI/ASHRAE/IES Standard 90.1-2019

Energy Standard for Buildings Except Low-Rise Residential Buildings

Approved by ASHRAE and the American National Standards Institute on June 30, 2020, and by the Illuminating Engineering Society on May 19, 2020.

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FOREWORD

This addendum makes three changes to Normative Appendix G.

a. It ensures that lighting power is determined using the same approach (Building Area Method versus Space-by-Space Method) for situations where a lighting system neither exists nor has been designed. It requires that both proposed and baseline lighting power be determined according to the Space-by-Space Method if space types are known, and according to the Building Area Method if they are not.

b. It ensures that the impact of exceeding the power limits for exterior lighting of nontradable surfaces is captured by requiring that the baseline building lighting power be the same as the proposed, or equal to the baseline defaults, whichever is less.

c. A baseline allowance is added for retail display lighting that is equal to the proposed design.

This addendum impacts an optional performance path in the standard designed to provide increased flexibility and therefore was not subjected to cost effectiveness analysis.

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

Addendum af to Standard 90.1-2019

Revise Table G3.1 as shown (I-P and SI units).

Table G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
6. Lighting		
	Lighting power in the *proposed design* shall be determined as follows: a. Where a complete *lighting system* exists, the actual lighting power for each *thermal block* shall be used in the model. b. Where a complete *lighting system* has been designed and submitted with design documents, lighting power shall be determined in accordance with Sections 9.1.3 and 9.1.4. c. Where lighting neither exists nor is submitted with design documents, lighting shall comply with but not exceed the requirements of Section 9. Where *space* types are known, lighting power shall be determined in accordance with the Space-by-Space Method. Where *space* types are not known, lighting ~~Lighting~~ power shall be determined in accordance with the *Building* Area Method. d. *Lighting system* power shall include all *lighting system* components shown or provided for on the plans (including *lamps* and *ballasts* and task and furniture-mounted *fixtures*). e. For *dwelling units*, hotel/motel guest rooms, and other *spaces* in which lighting systems are connected via receptacles and are not shown on design documents, lighting power used in the simulation shall be equal to the lighting power allowance in Table 9.6.1 for the appropriate space type or as designed, whichever is greater. For the dwelling units, lighting power used in the simulation shall be equal to 0.60 W/ft^2 (6.5 W/m^2) or as designed, whichever is greater. **Exception:** Lighting use can be reduced for the portion of the space illuminated by the specified fixtures provided that they maintain the same illuminance level as in the baseline. Such reduction shall be demonstrated by calculations. f. Exterior lighting power and lighting ~~Lighting~~ power for parking garages ~~and building façades~~ shall be modeled. g. For lighting controls, at a minimum, the proposed design shall contain the mandatory automatic lighting controls specified in Section 9.4.1 (e.g., automatic daylight responsive controls, occupancy sensors, programmable controls, etc.). These controls shall be modeled in accordance with (g) and (h). h. Automatic daylighting responsive controls shall be modeled directly in the proposed design or through schedule adjustments determined by a separate daylighting analysis approved by the rating authority. Modeling and schedule adjustments shall separately account for primary sidelighted areas, secondary sidelighted areas, and toplighted areas. i. Other automatic lighting controls included in the proposed design shall be modeled directly in the building simulation by reducing the lighting schedule each hour by the occupancy sensor reduction factors in Table G3.7 for the applicable space type. This reduction shall be taken only for lighting controlled by the occupancy sensors. Credit for other programmable lighting control in buildings less than 5000 ft^2 (500 m^2) can be taken by reducing the lighting schedule each hour by 10%.	Interior lighting power in the *baseline building design* shall be determined using the values in Table G3.7. However, where lighting neither exists nor is submitted with design documents, and the *proposed design* lighting power is determined in accordance with the *Building* Area Method, the *baseline building design* lighting power shall be determined in accordance with Table G3.8. Where retail display lighting is included in the *proposed building design* in accordance with Section 9.6.2(b), the *baseline building design* retail display lighting additional power shall be equal to the limits established by Section 9.6.2(b) or same as proposed, which ever less. Lighting shall be modeled having the automatic shutoff controls in buildings >5000 ft^2 (500 m^2) and occupancy sensors in employee lunch and break rooms, conference/meeting rooms, and classrooms (not including shop classrooms, laboratory classrooms, and preschool through 12th-grade classrooms). These *controls* shall be reflected in the *baseline building design* lighting schedules. No additional *automatic* lighting *controls,* e.g., *automatic controls* for daylight utilization and *occupancy sensors* in *space* types not listed above, shall be modeled in the *baseline building design*. Exterior lighting in areas that are designed to be illuminated and identified as "Tradable Surfaces" in Table G3.6 shall be modeled with the baseline lighting power shown in Table G3.6. Other exterior lighting shall be modeled the same in the *baseline building design* as in the *proposed design*.

Modify Table G3.6 as shown (I-P units).

Table G3.6 ***Performance Rating Method Lighting Power Densities*** **for** ***Building*** **Exteriors**

Tradable Surfaces (*Lighting power densities* for uncovered parking areas, *building* grounds, *building entrances* and exits, canopies and overhangs and outdoor sales areas may be traded.)	Uncovered Parking Areas	
	Parking lots and drives	0.15 W/ft^2
	Building Grounds	
	Walkways less than 10 ft wide	1.0 W/linear foot
	Walkways 10 ft wide or greater Plaza areas Special feature areas	0.2 W/ft^2
	Stairways	1.0 W/ft^2
	Building Entrances and Exits	
	Main entries	30 W/linear foot of *door* width
	Other *doors*	20 W/linear foot of *door* width
	Canopies and Overhangs	
	Canopies (free standing and attached and overhangs)	1.25 W/ft^2
	Outdoor Sales	
	Open areas (including vehicle sales lots)	0.5 W/ft^2
	Street frontage for vehicle sales lots in addition to open-area allowance	20 W/linear foot
~~**Nontradable Surfaces (*Lighting power density* calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)**~~	~~*Building* Façades~~	~~0.2 W/ft^2 for each illuminated wall or surface or 5.0 W/linear foot) for each illuminated wall or surface length~~
	~~Automated Teller Machines (ATMs) and Night Depositories~~	~~270 W per location plus 90 W per additional ATM per location~~
	~~Entrances and Gatehouse Inspection Stations at Guarded Facilities~~	~~1.25 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")~~
	~~Loading Areas for Law Enforcement, Fire, Ambulance and Other Emergency *Service* Vehicles~~	~~0.5 W/ft^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")~~
	~~Drive-up Windows at Fast-Food Restaurants~~	~~400 W per drive-through~~
	~~Parking Near 24-Hour Retail Entrances~~	~~800 W per main entry~~

Modify Table G3.6 as shown (SI units).

Table G3.6 ***Performance Rating Method Lighting Power Densities*** **for** ***Building*** **Exteriors**

Tradable Surfaces (*Lighting power densities* for uncovered parking areas, *building* grounds, *building entrances* and exits, canopies and overhangs and outdoor sales areas may be traded.)	Uncovered Parking Areas	
	Parking lots and drives	1.6 W/m^2
	Building Grounds	
	Walkways less than 3 m wide	3.3 W/linear metre
	Walkways 3 m wide or greater	
	Plaza areas	2.2 W/m^2
	Special feature areas	
	Stairways	10.8 W/m^2
	Building Entrances and Exits	
	Main entries	98 W/linear metre of *door* width
	Other *doors*	66 W/linear metre of *door* width
	Canopies and Overhangs	
	Canopies (free standing and attached and overhangs)	13.5 W/m^2
	Outdoor Sales	
	Open areas (including vehicle sales lots)	5.4 W/m^2
	Street frontage for vehicle sales lots in addition to open-area allowance	66 W/linear metre
~~**Nontradable Surfaces (*Lighting power density* calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)**~~	~~*Building* Façades~~	~~2.2 W/m^2 for each illuminated wall or surface or 5.0W/linear metre for each illuminated wall or surface length~~
	~~Automated Teller Machines (ATMs) and Night Depositories~~	~~270 W per location plus 90 W per additional ATM per location~~
	~~Entrances and Gatehouse Inspection Stations at Guarded Facilities~~	~~13.5 W/m^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")~~
	~~Loading Areas for Law Enforcement, Fire, Ambulance and Other Emergency *Service* Vehicless~~	~~5.4 W/m^2 of uncovered area (covered areas are included in the "Canopies and Overhangs" section of "Tradable Surfaces")~~
	~~Drive-up Windows at Fast-Food Restaurants~~	~~400 W per drive-through~~
	~~Parking Near 24-Hour Retail Entrances~~	~~800 W per main entry~~

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FOREWORD

Boilers represent 40% of the heating in commercial buildings and are especially prevalent in cold climates. In 2010, efficiency improvements were implemented in Table 6.8.1-6, and additional improvements are scheduled for 2020 for gas-fired natural draft, but all these levels are defined to not achieve condensing boiler level efficiency. A challenge for condensing boilers for hot-water heating is that they require system design changes and the use of higher delta entering and leaving temperature to maintain condensing operation to ensure they operate efficiently.

Addendum bc adds an implementation of condensing boilers for new construction to achieve condensing-level efficiency (i.e., 90% E_t) for large boiler systems (i.e., between 1 million and 10 million Btuh), where the proper design considerations are included so that the condensing boilers will operate properly. To ensure condensing occurs, requirements are added to ensure boiler entering water temperature is designed to be low, and able to be maintained low, by minimizing recirculation of hot-water supply into the return.

First cost was determined from the 2012 GSA Condensing Boiler Study, which estimates $38.50/MBtu for noncondensing and $42.60/MBtu for condensing boilers. In addition, the study estimates an additional average annual maintenance cost of $400 for condensing boilers. Energy savings were found using energy modeling simulations run using USDOE's EnergyPlus. Three prototype buildings were used—large office, hospital, and secondary school—in various U.S. climate zones. A blended cost of $0.10/kWh was assumed.

Using the Standard 90.1 scalar ratio, the economic analysis shows an average scalar ratio of 4.2. The maximum scalar ratio of 17.2 for boilers with a life expectancy of 25 years. Models and estimates show that all prototypes fall within the maximum scalar ratio and are cost-effective.

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Addendum bc to Standard 90.1-2019

Add new Section 6.5.4.8 (I-P and SI units).

6.5.4.8 Buildings with High-Capacity Space-Heating Gas Boiler Systems. New buildings with gas hot-water *boiler systems* for space heating with a total *system* input of at least 1,000,000 Btu/h (290 kW) but not more than 10,000,000 Btu/h (2900 kW) shall comply with Sections 6.5.4.8.1 and 6.5.4.8.2.

Exceptions to 6.5.4.8:

1. Where 25% of the annual space heating requirement is provided by on-site renewable energy, *site-recovered energy*, or heat recovery chillers.
2. *Space heating boilers* installed in individual dwelling units.
3. Where 50% or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both.
4. Individual gas boilers with input capacity less than 300,000 Btu/h (87 kW) shall not be included in the calculations of the total system input or total system efficiency.

6.5.4.8.1 Boiler Efficiency. Gas hot-water *boilers* shall have a minimum thermal *efficiency* (E_t) of 90% when rated in accordance with the test procedures in Table 6.8.1-6. Systems with multiple boilers are allowed to meet this requirement if the space heating input provided by equipment with thermal *efficiency* (E_t) above and below 90% provides an input capacity-weighted average thermal *efficiency* of at least 90%. For boilers rated only for combustion *efficiency*, the calculation for the input capacity-weighted average thermal *efficiency* shall use the combustion *efficiency* value.

6.5.4.8.2 Hot-Water Distribution System Design. The hot-water distribution system shall be designed to meet all of the following:

a. Coils and other heat exchangers shall be selected so that at design conditions the hot-water return temperature entering the *boilers* is 120°F (49°C) or less.

b. Under all operating conditions, the water temperature entering the boiler is 120°F (49°C) or less, or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be no greater than 20% of the design flow of the operating boilers.

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FOREWORD

Addendum cd serves primarily to clarify the original intention for bypass and control to permit economizer operation. The bypass working group evaluated several systems and found that, with this proposal, a more clear control strategy is required where energy recovery systems are installed. Controls are already required by the standard; however, in some cases, compliance with the existing standard may result in less than optimum economizer operation and increased fan energy use.

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Addendum cd to Standard 90.1-2019

Modify Sections 6.5.6.1.2 as shown (I-P and SI).

6.5.6.1.2 Spaces Other than Nontransient Dwelling Units Each fan *system* serving spaces other than *nontransient dwelling units* shall have an *energy* recovery *system* where the design supply fan airflow rate exceeds the value listed in Tables 6.5.6.1.2-1 and 6.5.6.1.2-2, based on the climate zone and percentage of *outdoor air* at design airflow conditions. Table 6.5.6.1.2-1 shall be used for all *ventilation systems* that operate less than 8000 hours per year, and Table 6.5.6.1.2-1 shall be used for all *ventilation systems* that operate 8000 or more hours per year.

~~For spaces other than *nontransient dwelling units*, *energy* recovery *systems* shall result in an *enthalpy recovery ratio* of at least 50%. The *energy* recovery *system* shall provide the required *enthalpy recovery ratio* at both heating and cooling *design conditions*, unless one mode is not required for the climate zone by the exceptions below. Provision shall be made to bypass or *control* the *energy* recovery *system* to permit *air economizer* operation as required by Section 6.5.1.1.~~

Exceptions to 6.5.6.1.2:

1. Laboratory *systems* meeting Section 6.5.7.3.
2. *Systems* serving *spaces* that are not cooled and that are heated to less than 60°F.
3. Where more than 60% of the *outdoor air* heating *energy* is provided from *site-recovered energy* or *site-solar energy*.
4. *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1, and 2.
5. *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 3C, 4C, 5B, 5C, 6B, 7, and 8.
6. Where the sum of the airflow rates exhausted and relieved within 20 ft of each other is less than 75% of the design outdoor airflow rate, excluding exhaust air that is
   a. used for another *energy* recovery *system*,
   b. not allowed by ASHRAE Standard 170 for use in *energy* recovery *systems* with leakage potential, or
   c. of Class 4 as defined in ASHRAE Standard 62.1.
7. Systems in Climate Zones 0 through 4 requiring dehumidification that employ *series energy recovery* and have a minimum SERR of 0.40.
8. *Systems* expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table 6.5.6.1.2-1.
9. *Indoor pool dehumidifiers* meeting Section 6.5.6.4.

6.5.6.1.2.1 Minimum Enthalpy Recovery Ratio. *Energy* recovery *systems* required by this section shall result in an *enthalpy recovery ratio* of at least 50%. A 50% *enthalpy recovery ratio* shall mean a change in the enthalpy of the *outdoor air* supply equal to 50% of the difference between the *outdoor air* and entering exhaust air enthalpies at *design conditions*. The

energy recovery *system* shall provide the required *enthalpy recovery ratio* at both heating and cooling *design conditions* unless one mode is not required for the climate zone by Exception 6.5.6.1.2.2.

6.5.6.1.2.2 Provision for Air Economizer or Bypass Operation. Provision shall be made for both *outdoor air* and exhaust air to bypass or control the *energy* recovery *system* to enable *economizer* operation as required by Section 6.5.1.1. The bypass or *control* shall meet the following criteria:

a. For *energy* recovery *systems* where the transfer of *energy* cannot be stopped, bypass provision shall prevent the total airflow rate of either *outdoor air* or exhaust air through the *energy* recovery exchanger from exceeding 10% of the full design airflow rate.
b. The pressure drop of the *outdoor air* through the energy recovery exchanger shall not exceed 0.4 in. of water (100 Pa); the pressure drop of the exhaust air through the energy recovery exchanger shall not exceed 0.4 in. of water (100 Pa).

Exception to 6.5.6.1.2.2: *Energy* recovery *systems* with 80% or more *outdoor air* at full design airflow rate and not exceeding 10,000 cfm (4.72 m^3/s).

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FOREWORD

Addendum db clarifies how to establish the Normative Appendix G baseline space conditioning categories that must be used in conjunction with Tables G3.4-1 through G3.4-8.

Currently, the baseline space conditioning categories are the same as in the proposed design and are based on the definition of "space" in Section 3. As a result, if a conditioned space is designed to be low energy, the baseline for that space would end up being modeled based on the semiheated space envelope requirements rather than the more appropriate conditioned space envelope requirements.

In addition, the space conditioning categories in Section 3 have changed since 2004 (e.g., cooling space threshold has changed from 5 to 3.4 Btu/h·ft^2) and may change again in future editions of Standard 90.1. Therefore, using Section 3 to establish Appendix G baseline space conditioning categories conflicts with the intent to keep Appendix G baseline unchanged from edition to edition.

Addendum db incorporates the thresholds from Standard 90.1-2004 into Appendix G, so that the baseline envelope is not affected by the updates to Section 3. Additionally, it clarifies that heating and cooling loads used to establish baseline space conditioning category are determined by the baseline sizing runs.

This addendum impacts an optional performance path in the standard designed to provide increased flexibility and therefore was not subjected to cost effectiveness analysis.

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

Addendum db to Standard 90.1-2019

Revise Table G3.1 as shown (I-P and SI units).

Table G3.1 Modeling Requirements for Calculating Proposed and *Baseline Building Performance*

No.	Proposed *Building* Performance	*Baseline Building* Performance
5. *Building Envelope*		
a.	All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as built for *existing building envelopes*. **Exceptions:** The following *building* elements are permitted to differ from architectural drawings: 1. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate *floor* stabs, concrete *floor* beams over parking garages, *roof* parapet) shall be separately modeled using either of the following techniques: a. Separate model of each of these assemblies within the *energy* simulation model. b. Separate calculation of the *U-factor* for each of these assemblies. The *U-factors* of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average *U-factor* is modeled within the *energy* simulation model. Any other *building envelope* assembly that covers less than 5% of the total area of that assembly type (e.g., *exterior walls*) need not be separately described, provided that it is similar to an assembly being modeled. If not separately described, the area of a *building envelope* assembly shall be added to the area of an assembly of that same type with the same *orientation* and thermal properties. 3. Exterior surfaces whose azimuth *orientation* and tilt differ by less than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers.	Equivalent dimensions shall be assumed for each *building envelope* component type as in the *proposed design*; i.e., the total gross area of *walls* shall be the same in the *proposed design* and *baseline building design*. The same shall be true for the areas of roofs, *floors*, and *doors*, and the exposed perimeters of concrete slabs on *grade* shall also be the same in the *proposed design* and *baseline building design*. The following additional requirements shall apply to the modeling of the *baseline building design*: a. ***Orientation.*** The *baseline building performance* shall be generated by simulating the *building* with its actual *orientation* and again after rotating the entire *building* 90, 180, and 270 degrees, then averaging the results. The *building* shall be modeled so that it does not shade itself. **Exceptions:** 1. If it can be demonstrated to the satisfaction of the *rating authority* that the *building orientation* is dictated by site considerations. 2. *Buildings* where the *vertical fenestration area* on each *orientation* varies by less than 5%. b. ***Space Conditioning Categories.*** *Space conditioning categories* used to determine applicability of the envelope requirements in Tables G3.4-1 through G3.4-8 shall be the same as in the proposed design. **Exception:** Envelope components, of the HVAC zones that are semi-heated in the proposed design must meet conditioned envelope requirements in Tables G3.4-1 to G3.4-8 if, based on the sizing runs, these zones are served by a baseline system with sensible cooling output capacity ≥5 Btu/h·ft^2 (15 W/m^2) of floor area, or with heating output capacity greater than or equal to the criteria in Table G3.4-9, or that are *indirectly conditioned* spaces. c. ***Opaque* Assemblies.** *Opaque* assemblies used for new *buildings*, *existing buildings*, or additions shall conform with assemblies detailed in Normative Appendix A and shall match the appropriate assembly maximum *U-factors* in Tables G3.4-1 through G3.4-8: • Roofs—Insulation entirely above deck (A2.2). • *Above-grade walls—Steel-framed* (A3.3). • *Below-grade walls*—Concrete block (A4). • *Floors—Steel-joist* (A5.3). • *Slab-on-grade floors* shall match the *F-factor* for unheated slabs from the same tables (A6).

Add new Table G3.4-9 as shown (I-P and SI).

Table G3.4-9 Heated Space Criteria

Climate Zone	Heating Output, Btu/h·ft^2 (W/m^2)
0, 1, 2	≥5 (15)
3	≥10 (30)
4, 5	≥15 (45)
6,7	≥20 (60)
8	≥25 (75)

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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.

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