NYStretch Energy Code 2023

Commercial Draft

*Draft V2.0 For Public Comment*

VERSION 2.0:

A Supplement to the 2021 International Energy Conservation Code and

ASHRAE Standard 90.1-2019

Published by the New York State Energy Research and Development Authority

*DATE, 2022*

INTRODUCTION

The NYStretch Energy Code-2023 project was undertaken by New York State Energy Research and Development Authority (NYSERDA) to develop a pivotal tool for New York jurisdictions to support the State’s energy and climate goals by providing greater savings over the State Energy Conservation Construction Code (the “State Energy Code”) for both residential and commercial buildings.

The State Energy Code establishes energy conservation standards for the design and construction of all public and private buildings in the State. The State Energy Code is adopted by the State Fire Prevention and Building Code Council (the “Code Council”) pursuant to Article 11 of the Energy Law and is applicable in all parts of the State. However, Article 11 of the Energy Law authorizes municipalities to adopt local energy conservation construction codes (“Local Energy Codes”) that are more stringent than the State Energy Code.

NYSERDA developed a publication entitled NYStretch Energy Code – 2023, Version 2.0 (“NYStretch”) that makes changes to certain provisions in 2021 International Energy Conservation Code (2021 IECC) and ASHRAE 90.1-2019 to add energy saving and clean energy provisions. NYSERDA designed NYStretch in a way that allows a municipality to readily adopt a more stringent Local Energy Code by adopting NYStretch as a supplement to the State Energy Code. NYStretch is not intended to be used as a standalone energy code. It was developed with the goal to be:

1. Technically sound
2. Thoroughly reviewed by stakeholders
3. Written in code enforceable language

DISCLAIMER

This is a draft document containing strikethrough/underline language for public comment purposes exclusively. Revisions to Part 1: Section C405.13 and Part 2: Section 10.5.1 were done in consultation with ASHRAE SSPC 189.1 and provided with permission from ASHRAE. These changes are part of WG07DA23D (Proposed Addendum ac) and are subject to change as they undergo the ASHRAE publication/public review process.

ACKNOWLEDGEMENTS

NYSERDA gratefully thanks and acknowledges the following individuals who contributed to the development of NYStretch Energy Code-2023:

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PART 1

# Amendments to 2021 International Energy Conservation Code Commercial Provisions

Preface

This draft NYStretch-2023 code language is based on materials presented to an engaged stakeholder group. In addition to input from Public Comment period #1, feedback was collected in Advisory Group meetings, Commercial Working Group meetings and Subtopic Working Group meetings. Language in Part 1 of this document is presented as changes to 2021 IECC (as published).

## Amendments to Section [NY] C103 Construction Documents

Add new construction documentation requirement to section C103.2:

**C103.2 Information on construction documents.**

…Details shall include, but are not limited to, the following as applicable:

(…....)

13. Thermal bridges as identified in Section C402.6.

14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.

15. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.

16. Location and layout of a designated area for ESS.

17. Rated energy capacity and rated power capacity of the installed or planned ESS.

18. Location and layout of *electric vehicle automobile parking spaces*, designating *EVSE*-, *EV capable*, and *EV ready spaces*.

## Amendments to Section [NY] C202 General Definitions

Section C202 of the 2021 IECC Commercial Provisions shall be amended to read as follows:

**GREENHOUSE.** A structure or a thermally isolated area of a building that maintains a specialized sunlit environment with a skylight roof ratio of 50% or more above the growing area exclusively used for, and essential to, the cultivation, protection or maintenance of plants. Greenhouses are those that are erected for a period of 180 days or more.

Section C202 of the 2021 IECC Commercial Provisions shall be amended by the addition of new definitions as follows:

**AUTOMOBILE PARKING SPACE.** A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

**COMMERCIAL COOKING APPLIANCES**.Appliances used in a commercial food service establishment for heating or cooking food. For the purpose of the definition, a commercial food service establishment is where food is prepared for sale or is prepared on a scale that is by volume and frequency not representative of domestic household cooking.

**COMMON AREA.**All portions of Group R occupancies that are not dwelling units or sleeping units.

**COMMUNITY RENEWABLE ENERGY FACILITY.** A facility that produces energy harvested from *renewable energy resources* and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

**DEHUMIDIFIER.** A self-contained, electrically operated, and mechanically encased product with the sole purpose of dehumidifying the space consisting of:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere,
2. A refrigerating system, including an electric motor,
3. An air-circulating fan, and
4. A means for collecting or disposing of the condensate.

A dehumidifier does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner.

**DEMAND RESPONSE SIGNAL.** A signal that indicates a price or a request to modify electricity consumption for a limited time period.

**DEMAND RESPONSIVE CONTROL.** A control capable of receiving and automatically responding to a *demand response signal*.

**DESSICANT DEHUMIDIFICATION SYSTEM.** A mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.

**ELECTRIC VEHICLE (EV).** An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, *EVSE*, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

**ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the electric vehicle connectors, attached plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

**ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space).** An *automobile parking space* that is provided with a dedicated *EVSE* connection

**ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE).** A designated *automobile parking space* that is provided with electrical infrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an *EVSE*.

**ELECTRIC VEHICLE READY SPACE (EV READY SPACE).** An *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE*.

**ENERGY STORAGE SYSTEM (ESS).**One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

**EXISTING BUILDING.**a *building* or portion thereof that was previously occupied or approved for occupancy by a *code official*.

**FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT.** A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

**HORTICULTURAL LIGHTING.** Electric lighting used for horticultural production, cultivation or maintenance.

**INDOOR GROW.** A space, other than a greenhouse, used exclusively for, and essential to horticultural production, cultivation or maintenance.

**INTEGRATED HVAC SYSTEM**. An HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems include, but are not limited to HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and dehumidifiers modified to allow external heat rejection.

**PHOTOSYNTHETIC PHOTON EFFICACY (PPE).** Photosynthetic photon flux emitted by a light source divided by its electrical input power in units of micromoles per second per watt, or micromoles per joule (μmol/J) between 400-700nm as defined by ANSI/ASABE S640.

**PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT.** A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

**RENEWABLE ENERGY CERTIFICATE (REC).** A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*, also known as "energy attribute" and "energy attribute certificate" (EAC).

**SUBSTANTIAL ENERGY ALTERATION.** An *alteration* that includes replacement of two or more of the following:

1. 50% or more of the area of interior wall-covering material of the building thermal envelope.
2. 50% or more of the area of the exterior wall-covering material of the building thermal envelope.
3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the building.
4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the building.
5. 50% or more of the luminaires in the building

**THERMAL BRIDGE.** An element or interface of elements that has higher thermal conductivity than the surrounding building thermal envelope, which creates a path of least resistance for heat transfer.

**CHI-FACTOR (χ-FACTOR).** The heat loss factor for a single thermal bridge characterized as a point element of a building thermal envelope (Btu/h x oF) [W/K].

**CLEAR FIELD THERMAL BRIDGE.** An area-based thermal transmittance associated with elements of a building envelope assembly which repeats at regular intervals. Examples of clear field thermal bridges include metal or wood studs, brick ties, and cladding attachments such as z-girts.

**CLEAR FIELD U-FACTOR.** Thermal performance factor that accounts for clear field thermal bridge.

**OVERALL U-FACTOR.** U-factor of above grade walls that includes clear field, linear, and point thermal bridges.

**PSI-FACTOR (ψ-FACTOR).** The heat loss factor per unit length of a thermal bridge characterized as a linear element of a building thermal envelope (Btu/h x ft x oF)[W/(m x K)].

**TOTAL SYSTEM PERFORMANCE RATIO (TSPR).** The ratio of the sum of a *building’s* annual heating and cooling load in thousand Btu to the sum of annual site energy input of the *building* mechanical systems.

**SERVICE HOT WATER**. Heating water for domestic or commercial purposes other than space heating and process application requirements. Abbreviated as SHW.

**~~FUEL GAS.~~** ~~A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.~~

## Amendments to Section [NY] C401.2 Application

Section C401.2 of the IECC 2021 Commercial Provisions shall be amended to read as follows:

**C401.2 Application.**

*Commercial buildings* shall comply with Section C401.2.1 or C401.2.2.

**C401.2.1 International Energy Conservation Code.**

*~~Commercial buildings~~* ~~shall comply with one of the following: [remove the “1” starting the paragraph]~~

~~Prescriptive Compliance: The Prescriptive Compliance option requires compliance~~ *Commercial* *buildings* shall comply with Sections C402 through C406 and C408~~, and, if adopted by local ordinance, Appendix CB~~. ~~Dwelling units and sleeping units in Group R-2 buildings without systems servings multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.~~

**Exception:** Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter C5.

**C401.2.2 ASHRAE 90.1.**

*Commercial buildings* shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1-2019 (as amended by Part 2 of this document).

## Amendments to Section C402 Building Envelope Requirements

Amend Section C402.1 of the IECC 2021 Commercial Provisions as follows:

**C402.1 General (Prescriptive).**

*Building thermal envelope* assemblies ~~for~~ *~~buildings~~* ~~that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1,~~ shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation installation requirements of Section C402.2, as applicable; and the thermal requirements of the *U-, C- and F-*factor-based method of Section C402.1.4 or the building envelope trade-off alternative of section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. *Fenestration* in *building* envelope assemblies shall comply with Section C402.4.
4. Air leakage of *building* envelope assemblies shall comply with Section C402.5.
5. U-factor calculations shall include *thermal bridges* per Section C402.6.

Alternatively, where *buildings* have a *vertical fenestration* area or skylight area exceeding that allowed in Section C402.4, the *building* and *building* *thermal envelope* shall comply with Section C402.1.5 or Section C401.2.2. Where buildings are 7 stories or more above grade, Section C402.1.6 shall be permitted.

*Walk-in coolers*, *walk-in freezers*, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

## Replacement and Renaming of Section C402.1.3

Delete R-value-based envelope compliance and replace with language modified and moved from C402.5.5 Rooms containing fuel-burning appliances, as follows:

**~~C402.1.3 Insulation component R-value-based method.~~**

**~~TABLE C402.1.3~~** **~~OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD~~**

**C402.1.3 Rooms containing fuel-burning appliances.** Where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope.*
2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the *building thermal envelope*. Such rooms shall comply with all of the following:
   1. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1.4.
   2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.5.1.2.
   3. The doors into the enclosed room or space shall be fully gasketed.
   4. Piping serving as part of a heating or cooling system and ducts in the enclosed room or space shall be insulated in accordance with Section C403. Service water piping shall be insulated in accordance with Section C404.
   5. Where an air duct supplying combustion air to the enclosed room or space passes through *conditioned space*, the duct shall be insulated to an R-value of not less than R-8.

**Exception:** Fireplaces and stoves complying with MCNYS Sections 901 through 905 and BCNYS Section 2111.14.

## Amendments to C402.1.4 Assembly U-factor, C-factor or F-factor-based method

Amend Section C402.1.4 (assembly U-factor, C-factor or F-factor-based method) of the IECC 2021 Commercial Provisions as follows:

**C402.1.4 Assembly U-factor, C-factor or F-factor-based method**

Building thermal envelope opaque assemblies shall meet the requirements of Sections C402.2 and C402.4 based on the climate zone specified in Chapter C3. Building thermal envelope opaque assemblies intended to comply on an assembly U-, C- or F-factor basis shall have a U-, C- or F-factor not greater than that specified in Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the U-, C- or F-factor from the “Group R” column of Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the U-, C- or F-factor from the “All other” column of Table C402.1.4.

The U-factor for above grade walls shall be calculated in accordance with Section C402.6.

## Delete and Replace Table C402.1.4

Delete Table C402.1.4 and replace with table below:

**Table C402.1.4**

**Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Methoda,b**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Climate Zone** | **4** | | | **5** | | | **6** | |
| **All other** | | **Group R** | **All other** | | **Group R** | **All other** | **Group R** |
| **Roofs** | | | | | | | | |
| Insulation Entirely above deck | 0.016 | | 0.016 | 0.016 | | 0.016 | 0.014 | 0.014 |
| Metal buildings | 0.016 | | 0.016 | 0.016 | | 0.016 | 0.014 | 0.014 |
| Attic and other | 0.013 | | 0.013 | 0.013 | | 0.013 | 0.012 | 0.012 |
| **Walls, above gradei** | | | | | | | | |
| Mass**f** | 0.056 | | 0.053 | 0.053 | | 0.050 | 0.050 | 0.047 |
| Metal building | 0.058 | | 0.057 | 0.055 | | 0.054 | 0.052 | 0.051 |
| Metal framed | 0.058 | | 0.057 | 0.055 | | 0.054 | 0.052 | 0.051 |
| Wood framed and other | 0.039 | | 0.040 | 0.036 | | 0.037 | 0.033 | 0.034 |
| **Walls, below grade** | | | | | | | | |
| Below-grade wall**c** | C-0.059 | | C-0.060 | C-0.061 | | C-0.062 | C-0.048 | C-0.048 |
| **Floors** | | | | | | | | |
| Mass**d** | 0.053 | | 0.053 | 0.053 | | 0.053 | 0.043 | 0.043 |
| Joist/framing | 0.054 | | 0.054 | 0.054 | | 0.054 | 0.044 | 0.044 |
| **Slab-on-grade floors** | | | | | | | | |
| Unheated slabs | F-0.52 | | F-0.52 | F-0.52 | | F-0.52 | F-0.51 | F-0.51 |
| Heated slabs | F-0.62 | | F-0.62 | F-0.62 | | F-0.62 | F-0.62 | F-0.60 |
| **Opaque doors** | | | | | | | | |
| Non-swinging | | 0.31 | 0.31 | 0.31 | 0.31 | | 0.31 | 0.31 |
| Swinging**g** | 0.37 | | 0.37 | 0.37 | | 0.37 | 0.37 | 0.37 |
| Garage door <14% glazing**h** | 0.31 | | 0.31 | 0.31 | | 0.31 | 0.31 | 0.31 |

For SI: 1 pound per square foot = 4.88 kg/m2, 1 pound per cubic foot = 16 kg/m3.

* 1. Where assembly *U-factors*, *C-factors* and *F-factors* are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A, and thermal bridging is calculated in accordance with C402.6.
  2. Where *U-factors* have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, provided that the tested assembly contained thermal bridging details representative of the assembly installed in the building. The *R-value* of continuous insulation shall be permitted to be added to or subtracted from the original tested design, accounting for thermal bridging in accordance with C402.6.
  3. Where heated slabs are below grade, below-grade walls shall comply with the *U-factor* requirements for above-grade mass walls.
  4. “Mass floors” shall be in accordance with Section C402.2.3.
  5. ***Reserved***
  6. “Mass walls” shall be in accordance with Section C402.2.2.
  7. Swinging door *U-factors* shall be determined in accordance with NFRC-100.
  8. Garage doors having a single row of fenestration shall have an assembly *U-factor* less than or equal to 0.36, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.
  9. *Walls, above grade U-factors* include thermal bridging impact calculated in accordance with C402.6.

## Addition of New Section C402.1.4.3 Thermal Resistance of Spandrel Panels

Addition of new Section C402.1.4.3 as follows:

**C402.1.4.3Thermal Resistance of Spandrel Panels.**

U-factors of opaque assemblies within fenestration framing systems shall be determined in accordance with the default values in Table C402.1.4.3, ASTM C1363, or ANSI/NFRC 100.

**TABLE C402.1.4.3** **EFFECTIVE *U*-FACTORS FOR SPANDREL PANELSa**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rated R-value of Insulation between Framing Members | | |  |  |  |  |  |  |  |
| R-4 | R-7 | R-10 | R-15 | R-20 | R-25 | R-30 |
| Frame Type | | Spandrel Panel | Default U-factor | | | | | | |
| Aluminum without Thermal Breakb | | Single glass pane, stone, or metal panel | 0.285 | 0.259 | 0.247 | 0.236 | 0.230 | 0.226 | 0.224 |
| Double glazing with no low-e coatings | 0.273 | 0.254 | 0.244 | 0.234 | 0.229 | 0.226 | 0.223 |
| Triple glazing or double glazing with low-e glass | 0.263 | 0.249 | 0.241 | 0.233 | 0.228 | 0.225 | 0.223 |
| Aluminum with Thermal Breakc | | Single glass pane, stone, or metal panel | 0.243 | 0.212 | 0.197 | 0.184 | 0.176 | 0.172 | 0.169 |
| Double glazing with no low-e coatings | 0.228 | 0.205 | 0.193 | 0.182 | 0.175 | 0.171 | 0.168 |
| Triple glazing or double glazing with low-e glass | 0.217 | 0.199 | 0.189 | 0.180 | 0.174 | 0.170 | 0.167 |
| Structural Glazingd | | Single glass pane, stone, or metal panel | 0.217 | 0.180 | 0.161 | 0.145 | 0.136 | 0.130 | 0.126 |
| Double glazing with no low-e coatings | 0.199 | 0.172 | 0.157 | 0.143 | 0.135 | 0.129 | 0.126 |
| Triple glazing or double glazing with low-e glass | 0.186 | 0.165 | 0.152 | 0.140 | 0.133 | 0.128 | 0.125 |
| No framing or Insulation is Continuouse | | Single glass pane, stone, or metal panel | 0.160 | 0.108 | 0.082 | 0.058 | 0.045 | 0.037 | 0.031 |
| Double glazing with no low-e coatings | 0.147 | 0.102 | 0.078 | 0.056 | 0.044 | 0.036 | 0.030 |
| Triple glazing or double glazing with low-e glass | 0.139 | 0.098 | 0.076 | 0.055 | 0.043 | 0.035 | 0.030 |
| a. | Extrapolation outside of the table shall not be permitted. Assemblies with distance between framing less than 30 inches (762 mm), or not included in the default table, shall have a *U-factor* determined by testing in compliance with ASTM C1363 or modeling in compliance with ANSI/NFRC 100. Spandrel panel assemblies in the table do not include metal backpans. For designs with metal backpans, multiply the U-factor by 1.20. | | | | | | | | |
| b. | This frame type shall be used for systems that do not contain a non-metallic element that separates the metal exposed to the exterior from the metal that is exposed to the interior condition. | | | | | | | | |
| c. | This frame type shall be used for systems where a urethane or other non-metallic element separates the metal exposed to the exterior from the metal that is exposed to the interior condition. | | | | | | | | |
| d. | This frame type shall be used for systems that have no exposed mullion on the exterior. | | | | | | | | |
| e. | This frame types shall be used for systems where there is no framing or the insulation is continuous and uninterrupted between framing. | | | | | | | | |

## Addition of New Section C402.1.4.4 Thermal resistance of mechanical equipment penetrations

Add new Section C402.1.4.4 Thermal resistance of mechanical equipment penetrations as follows:

**C402.1.4.4 Thermal resistance of mechanical equipment penetrations.** When the total area of penetrations from through-the-wall mechanical equipment or equipment listed in Table C403.3.2(4) exceeds 1 percent of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5.

**Exception:** Where mechanical equipment has been tested in accordance with testing standards approved by the authority having jurisdiction, the mechanical equipment penetration area may be calculated as a separate wall assembly with the U-factor as determined by such test.

## Deletion and Replacement of Section C402.1.5 Component performance alternative

Delete section C402.1.5 Component performance alternative and replace with language below:

**C402.1.5 Component performance alternative.** ANSI/ASHRAE/IESNA 90.1-2019 Normative Appendix C shall be permitted for envelope trade-off compliance. All amendments in Part 2 of this document shall apply.

## Addition of New Section C402.1.6 High-rise Prescriptive Alternative

**C402.1.6 High-rise prescriptive alternative.**

*Buildings* not less than 7 stories above grade shall comply with the following:

1. For walls, above grade, in Table C402.1.4, the maximum U-factor shall be 0.088. U-factor area-weighting shall be permitted across vertical opaque assemblies. All other opaque assembly requirements apply.
2. For vertical *fenestration* in Table C402.4, the maximum U-factor shall be 0.28. U-factor area-weighting shall be permitted across vertical fenestration categories. All other fenestration requirements apply.
3. C406.2.2.1 H01 HVAC Total System Performance (TSPR) for the occupancy class.
4. *Service hot water* loads shall be met with heat-pump or tankless electric water heaters.
5. The building envelope shall be commissioned in accordance with ASTM E2813.

## Deletion and Replacement of Section C402.2 Specific building thermal envelope insulation requirements

Delete Section C402.2 and replace with language below:

**C402.2 Specific building thermal envelope insulation requirements.** Insulation in *building thermal envelope* opaque assemblies shall comply with Sections C402.2.1 through C402.2.7.

**C402.2.1 Roof assembly.** In addition to the requirements of C402.1.4.1 roofs shall comply with the following:

**C402.2.1.1 *Reserved***

**C402.2.1.2 Minimum thickness, lowest point.** The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

**C402.2.1.3** ***Reserved***

**C402.2.1.4** ***Reserved***

**C402.2.1.5 Skylight curbs.** Skylight curbs shall be insulated to the level of roofs with insulation entirely above the deck or R-5, whichever is less.

**Exception:** Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

**C402.2.2 Above-grade walls.** In determining compliance with Table C402.1.4, the use of the *U-*factor of concrete masonry units with integral insulation shall be permitted. “Mass walls” where used as a component in the thermal envelope of a building shall comply with one of the following:

1. Weigh not less than 35 pounds per square foot (171 kg/ m2) of wall surface area.
2. Weigh not less than 25 pounds per square foot (122 kg/ m2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m3).
3. Have a heat capacity exceeding 7 Btu/ft2 × °F (144 kJ/ m2 × K).
4. Have a heat capacity exceeding 5 Btu/ft2 × °F (103 kJ/ m2 × K), where the material weight is not more than 120 pcf (1900 kg/m3).

**C402.2.3 Floors.** The thermal properties (assembly *U-*, *C-* or *F*-factors) of floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1.4 based on the construction materials used in the floor assembly. Floor framing *cavity insulation* or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs. “Mass floors” where used as a component of the thermal envelope of a building shall provide one of the following weights:

1. 35 pounds per square foot (171 kg/m2) of floor surface area.
2. 25 pounds per square foot (122 kg/m2) of floor surface area where the material weight is not more than 120 pounds per cubic foot (1923 kg/m3).

**Exceptions:**

1. The floor framing *cavity insulation* or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where it extends from the bottom to the top of all perimeter floor framing or floor assembly members.
2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope*.

**C402.2.4 Slabs-on-grade.** The thermal properties of slabs-on-grade shall be as specified in Table C402.1.4.

**C402.2.4.1 Insulation installation.** Where installed, the perimeter insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The perimeter insulation shall extend downward from the top of the slab, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

**Exception:** Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

**C402.2.5 Below-grade walls.** The *C*-factor for the below-grade exterior walls shall be in accordance with Table C402.1.4. The insulation required shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.

**C402.2.6 Insulation of radiant heating systems.** *Radiant heating system* panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an *R*-value of not less than R*-*3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R-*value of insulation installed in the opaque assembly in which they are installed, or the assembly shall comply with Section C402.1.4.

**Exception:** Heated slabs on grade insulated in accordance with Section C402.2.4.

**C402.2.7 Airspaces.** Where the *R*-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in an unventilated cavity constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.

**Exception:** The thermal resistance of intentionally ventilated airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be permitted to be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

## Deletion and Replacement of Table C402.4 Fenestration

Delete Table C402.4 and replace with table below:

**C402.4**

**Building Envelope Fenestration Maximum U-Factor and SHGC Requirements**

|  |  |  |  |
| --- | --- | --- | --- |
| **Climate Zone** | **4** | **5** | **6** |
| **Vertical Fenestration** | | | |
| **U-Factor**a | | | |
| Fixed fenestration | 0.22 | 0.20 | 0.18 |
| Operable fenestration | 0.26 | 0.24 | 0.22 |
| Entrance doors | 0.55 | 0.55 | 0.55 |
| **SHGCb** | | | |
| PF <0.2 | 0.25 | 0.32 | 0.36 |
| 0.2=<PF=<0.5 | 0.30 | 0.38 | 0.43 |
| PF >=0.5 | 0.40 | 0.52 | 0.58 |
| **Skylights** | | | |
| U-Factora | 0.40 | 0.40 | 0.40 |
| SHGC**b** | 0.30 | 0.30 | 0.30 |

PF – Projection Factor

a. U-factor shall be rated in accordance with NFRC 100.

b. SHGC shall be rated in accordance with NFRC 200.

## Amendments to C402.4.3.1 and C402.4.3.2 Increased Skylight Allowances

Amend C402.4.3.1 and C402.4.3.2 to read as follows:

**C402.4.3.1 Increased skylight SHGC.**~~In~~ *~~Climate Zones~~* ~~1 through 6,~~ Skylights shall be permitted a maximum SHGC of ~~0.60~~ 0.40 where located above *daylight zones* provided with *daylight responsive controls*.

**~~C402.4.3.2 Increased skylight U-factor.~~**

~~Where skylights are installed above~~ *~~daylight zones~~* ~~provided with~~ *~~daylight responsive controls~~*~~, a maximum~~ *~~U~~*~~-factor of 0.9 shall be permitted in~~ *~~Climate Zones~~* ~~1 through 3 and a maximum~~ *~~U~~*~~-factor of 0.75 shall be permitted in~~ *~~Climate Zones~~* ~~4 through 8.~~

## Section 1.16

***Reserved***

## Deletion and replacement of section C402.5

Delete and replace C402.5 with the following:

**C402.5 Building envelope air leakage testing.** The *building thermal envelope* shall comply with Section C402.5.1 through Section C402.5.8.1.

**C402.5.1 Air barriers.** A continuous *air barrier* shall be provided throughout the *building thermal envelope*. The *air barrier* is permitted to be any combination of inside, outside, or within the *building thermal envelope* The *air barrier* shall comply with Sections C402.5.1.1, and C402.5.1.2. The *air leakage* performance of the *air barrier* shall be verified in accordance with Section C402.5.2.

**C402.5.1.1 Air barrier design and documentation requirements.** Design of the continuous *air barrier* shall be documented in the following manner:

1. Components comprising the continuous *air barrier* and their position within each *building thermal envelope* assembly shall be identified.
2. Joints, interconnections, and penetrations of the continuous *air barrier* components shall be detailed.
3. The continuity of the *air barrier* building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space shall be identified.
4. Documentation of the continuous air barrier shall detail methods of sealing the air barrier such as wrapping, caulking, gasketing, taping or other *approved* methods at the following locations:
   * + - 1. Joints around fenestration and door frames.
     1. Joints between walls and floors, between walls at building corners, between walls and roofs including parapets and copings, where above-grade walls meet foundations, and similar intersections.
     2. Penetrations or attachments through the continuous *air barrier* in building envelope roofs, walls, and floors.
     3. Building assemblies used as ducts or plenums.
     4. Changes in continuous *air barrier* materials and assemblies.
5. Identify where testing will or will not be performed in accordance with Section C402.5.2. Where testing will not be performed, a plan for field inspections required by C402.5.2.3 shall be provided that includes the following:
   1. Schedule for periodic inspection,
   2. Continuous air barrier scope of work,
   3. List of critical inspection items,
   4. Inspection documentation requirements, and
   5. Provisions for corrective actions where needed.

**C402.5.1.2 Air barrier construction.** The *continuous air barrier* shall be constructed to comply with the following:

1. The *air barrier* shall be continuous for all assemblies that comprise the *building thermal envelope* and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure differentials such as those from design wind loads, stack effect and mechanical ventilation.
3. Penetrations of the *air barrier* shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations’ ability to resist positive and negative pressure. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the fire sprinkler manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.1.2.1. Where similar objects are installed that penetrate the *air barrier*, provisions shall be made to maintain the integrity of the *air barrier*.
5. Electrical and communication boxes shall comply with C402.5.1.2.2.

**C402.5.1.2.1 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be all of the following:

1. IC-rated.

2. Labeled as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) where tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential.

3. Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

**C402.5.1.2.2 Electrical and communication boxes.** Electrical and communication boxes that penetrate the air barrier of the building thermal envelope, and that do not comply with C402.5.1.2.2.1, shall be caulked, taped, gasketed, or otherwise sealed to the air barrier element being penetrated. All openings on the concealed portion of the box shall be sealed. Where present, insulation shall rest against all concealed portions of the box.

**C402.5.1.2.2.1 Air-sealed boxes.** Where air-sealed boxes are installed, they shall be marked in accordance with NEMA OS 4. Air-sealed boxes shall be installed in accordance with the manufacturer's instructions.

**C402.5.2 Air leakage compliance.** *Air leakage* of the *building thermal envelope* shall be tested by an *approved* third party in accordance with C402.5.2.1. The measured *air leakage* shall not be greater than 0.15 cfm/ft2 of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated *building thermal envelope* surface area being the sum of the above- and below-grade *building thermal envelope*.

**Exceptions:**

1. For *existing buildings* where the measured *air leakage* rate is greater than 0.15 cfm/ft2 but is not greater than 0.40 cfm/ft2, the *approved* third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized along with a visual inspection of the *air barrier* in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging *existing building* components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured *air leakage rate* is greater than 0.40 cfm/ft2, corrective actions must be made to the building and an additional test completed for which the results are 0.40 cfm/ft2, or less.
2. As an alternative, buildings or portions of buildings, containing Group R and I occupancies, shall be permitted to be tested by an *approved* third party in accordance with C402.5.2.2. The reported *air leakage* of the *building thermal envelope* shall not be greater than 0.113 cfm/ft2 of the *testing unit enclosure area* at a pressure differential of 0.2 inch water gauge (50 Pa).

**C402.5.2.1 Whole building test method and reporting.** The *building thermal envelope* shall be tested for *air leakage* in accordance with ASTM E3158 or an equivalent *approved* method. A report that includes the tested surface area, floor area, volume of enclosure area, stories above grade, leakage rates and pressures, and descriptions of any sampling shall be submitted to the code official and the building owner.

**Exceptions:**

* 1. For buildings less than 10,000 ft2 (1000 m2) the entire *building thermal envelope* shall be permitted to be tested in accordance with ASTM E779, ASTM E3158 or ASTM E1827 or an equivalent *approved* method.
  2. For buildings greater than 50,000 ft2 (4645 m2), portions of the building shall be permitted to be tested and the measured *air leakage* shall be area-weighted by the surface areas of the *building thermal envelope* in each portion. The weighted average tested *air leakage* shall not be greater than the whole building leakage limit. The following portions of the building shall be tested:

1. The entire *building thermal envelope* area of stories that have any conditioned spaces directly under a roof.
2. The entire *building thermal envelope* area of stories that have a building entrance, a floor over unconditioned space, a loading dock, or that are below grade.
3. Representative above-grade portions of the building totaling not less than 25 percent of the wall area enclosing the remaining conditioned space.

**C402.5.2.2 Dwelling and sleeping unit enclosure test method and reporting.** The building thermal envelope shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the code official. Where multiple dwelling units or sleeping units or other enclosed spaces are contained within one building thermal envelope, each shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all tested unit results, weighted by the enclosure area of each tested unit. Units shall be tested without simultaneously testing adjacent units and shall be separately tested as follows:

1. Where buildings have fewer than eight total dwelling or sleeping units, each unit shall be tested.

2. For buildings with eight or more dwelling or sleeping units, sampling of the units is permitted providing the greater of seven units or 20 percent of the units in the building shall be tested, including a top floor unit, a middle floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of unit types and locations.

3. Enclosed spaces with not less than one exterior wall in the building thermal envelope shall be tested in accordance with C402.5.3.

**Exception:** Corridors, stairwells, and enclosed spaces having a conditioned floor area not greater than 1,500 ft2 shall be permitted to comply with Section C402.5.1.5 and either Section C402.5.1.3 or C402.5.1.4.

**C402.5.2.3 Building envelope design and construction verification criteria.** Where Sections C402.5.2.1 and C402.5.2.2 are not applicable, the installation of the continuous *air barrier* shall be verifiedby the *code official*, *a registered design professional* or *approved agency* in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1**.**
2. Inspection of continuous *air barrier* components and assemblies shall be conducted during construction to verify compliance with the requirements ofSections C402.5.2.3.1 or C402.5.2.3.2.The *air barrier* shall remain accessible for inspection and repair.
3. A final inspection report shall be provided for inspections completed by the *registered design professional* or *approved agency*. The inspection report shall be provided to the building owner or owner’s authorized agent and the *code official*. The report shall identify deficiencies found during inspection and details of corrective measures taken.

**C402.5.2.3.1 Materials.** Materials with an air permeability not greater than 0.004 cfm/ft2 (0.02 L/s × m2) under a pressure differential of 0.3 inch water gauge (75 Pa) where tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 below shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer’s instructions.

1. Plywood with a thickness of not less than 3/8 inch (10 mm).
2. Oriented strand board having a thickness of not less than 3/8 inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than 1/2 inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than 1/2 inch (12.7 mm).
5. Closed-cell spray foam having a density of not less than 1.5 pcf (2.4 kg/m3) and having a thickness of not less than 11/2 inches (38 mm).
6. Open-cell spray foam with a density greater than 0.4 and less than 1.5 pcf (0.6 and 2.4 kg/m3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than 1/2 inch (12.7 mm).
8. Cement board having a thickness of not less than 1/2 inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch (15.9 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.
16. Solid or hollow masonry constructed of clay or shale masonry units.

**C402.5.3 Air leakage of fenestration.** The *air leakage* of fenestration assemblies shall comply with Table C402.5.3. Testing shall be conducted by an accredited, independent testing laboratory in accordance with the applicable reference test standard in Table C402.5.3 and *labeled* by the manufacturer.

**Exceptions:**

1. Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.5.1.2.
2. Fenestration in buildings that are tested for *air leakage* of in accordance with Section C402.5.2 are not required to meet the air leakage requirements in Table C402.5.3.

**TABLE C402.5.3**

**MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES**

|  |  |  |
| --- | --- | --- |
| **FENESTRATION ASSEMBLY** | **MAXIMUM RATE (CFM/FT2)** | **TEST PROCEDURE** |
| Windows | 0.20a | AAMA/WDMA/CSA101/I.S.2/A440 or NFRC 400 |
| Sliding doors | 0.20a |
| Swinging doors | 0.20a |
| Skylights—with condensation weepage openings | 0.30 |
| Skylights—all other | 0.20a |
| Curtain walls | 0.06 | NFRC 400 or ASTM E283 at 1.57 psf (75 Pa) |
| Storefront glazing | 0.06 |
| Commercial glazed swinging entrance doors | 1.00 |
| Power-operated sliding doors and power operated folding doors | 1.00 |
| Revolving doors | 1.00 |
| Garage doors | 0.40 | ANSI/DASMA 105, NFRC 400, or ASTM E283 at 1.57 psf (75 Pa) |
| Rolling doors | 1.00 |
| High-speed doors | 1.30 |

For SI: 1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093 m2a. The maximum rate for windows, sliding and swinging doors, and skylights is permitted to be 0.3 cfm per square foot of fenestration or door area when tested in accordance with AAMA/WDMA/CSA101/I.S.2/A440 at 6.24 psf (300 Pa).

**C402.5.4 Doors and access openings to shafts, chutes, stairways, and elevator lobbies.** Doors and *access* openings from conditioned space to shafts, chutes, stairways, and elevator lobbies not within the scope of the fenestration assemblies covered by Section C402.5.3 shall be gasketed, weather-stripped or sealed.

**Exceptions:**

1. Door openings required to comply with Section 716 of the *International Building Code*.

2. Doors and door openings required by the *International Building Code* to comply with UL 1784.

**C402.5.5 Air intakes, exhaust openings, stairways, and shafts.** Stairway enclosures, elevator shaft vents and other outdoor air intakes, and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Section C403.7.7.

**C402.5.6 Vestibules.** Building entrances shall be protected with an enclosed vestibule. Doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

**Exceptions:** Vestibules are not required for the following:

1. ***Reserved***

2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.

3. Doors opening directly from a *sleeping unit* or dwelling unit.

4. Doors that open directly from a space less than 3,000 square feet (298 m2) in area.

5. Revolving doors.

6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

**C402.5.7 Loading dock weather seals.** Cargo door openings and loading door openings shall be equipped with weather seals that restrict *air leakage* and provide direct contact along the top and sides of vehicles that are parked in the doorway.

**C402.5.8 Operable openings interlocking.** Where occupancies have operable openings to the outdoors that are larger than 40 square feet (3.7 m2) in area, such openings shall be interlocked with the heating and cooling system to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur when the operable opening has been open for a period not to exceed 10 minutes.

**Exceptions:**

1. Operable openings into separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.

2. Storage occupancies that utilize overhead doors for the function of the occupancy, where *approved*.

3. Doors located in the exterior wall that are part of a vestibule system.

**C402.5.8.1 Operable controls.** Controls shall comply with Section C403.13.

Addition of New Section C402.6 Thermal bridging documentation and calculations

Add Section C402.6 as follows:

**C402.6 Thermal bridging documentation and calculation (Mandatory)**

Construction documents shall provide details of assembly intersections described in Section C402.6.1 below, including:

1. Clear field thermal bridges, determined using ASHRAE 90.1 2019 Appendix A.
2. Linear thermal bridges, including total length of each type in Table C406.2.1, corresponding Psi-factors, and their source.
3. Point thermal bridges, including their cross-sectional area and quantity of each type, corresponding Chi-factors, and their source~~,~~

**Exception to C402.6(3):** *Point thermal bridges* related to HVAC or electrical systems totaling less than 12 square inches of cross-sectional area at exposure.

1. The overall assembly U-factor calculated in accordance with Section C402.6.~~4~~2 and including the U-factors for all intersections described in Section C402.6.1.

**C402.6.1 Accounting for Thermal Bridging (Mandatory)**

The calculated overall U-factor shall include the following intersections where they occur in the building:

1. Structural framing and members.
2. Cladding attachment systems
3. ~~A~~ssembly intersections:
   1. Roof edge
   2. Parapet
   3. Intermediate floor balcony or overhang to opaque wall intersection
   4. Intermediate floor balcony in contact with vertical fenestration
   5. Cladding support
   6. Wall to vertical fenestration intersection

**C402.6.2 Overall U-factor calculation of above-grade wall assembly (Mandatory)**

Where a thermal bridge is not accounted for as a separate element, the clear-field U-factors of above-grade wall assemblies shall be modified in accordance with Equation C402.6.2.

Utot = ( [ ( ∑ ψi ∙ Li ) + ( ∑ χj ∙ nj ) ] /Atotal )+Uo (Equation C402.6.2)

where

Utot = overall thermal transmittance including the effect of *linear thermal bridges* and *point thermal bridges* not included in the assembly’s Uo value, Btu/(h∙ft2∙oF) or W/(m2∙K)

Uo = clear field thermal transmittance of the assembly as determined in accordance with Section 5, Btu/(h∙ft2∙oF) or W/(m2∙K)

Atotal = total *opaque* projected surface area of the assembly, in ft2 (m2)

ψi = *Psi-factor*, thermal transmittance for each type of *linear thermal bridge*, Btu/(h·ft·°F) (W/(m·K))

Li = length of a particular *linear thermal bridge* as measured on the outside surface of the *building envelope*, ft (m)

χi = *Chi-factor*, thermal transmittance for each detail type of *point thermal bridge*, Btu/(h·°F) (W/K)

ni = the number of occurrences a particular type of *point thermal bridge*

**C402.6.3 Determination of Psi-factors and Chi-factors (Mandatory)**

Psi- and chi- factors shall be calculated or derived using:

1. Simulation models ~~compliant~~ in accordance with ISO 10211, Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations.
2. Assembly testing in accordance with ASTM C1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
3. ISO 14683, Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values.
4. BC Hydro’s Building Envelope Thermal Bridging Guide.
5. Table C402.6.1, for above-grade wall psi factors that are provided for use when thermal bridging mitigation is not specified and not implemented.

## Addition of Table C402.6.1 Default Psi-Factors

Add table C402.6.1

**Table C402.6.1 Default Psi-Factors**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Assembly Type | Thermal Bridge Factors | Roof Edge | Parapet | Intermediate floor to wall intersection | Intermediate floor balcony or overhang to opaque wall intersection | Intermediate floor balcony in contact with Vertical Fenestration | Cladding Support | Wall to Vertical Fenestration intersection |
| Metal-framed and Metal Buildings | Psi-Factor | 0.45 | 0.289 | 0.487 | 0.487 | 0.974 | 0.314 | 0.262 |
| Mass (exterior or integral) | Psi-Factor | 0.5 | 0.238 | 0.476 | 0.476 | 0.974 | 0.27 | 0.188 |
| Mass (interior) | Psi-Factor | 0.5 | 0.511 | 0.476 | 0.476 | 0.974 | n/a | 0.313 |
| Wood-framed and Other | Psi-Factor | 0.45 | 0.032 | 0.336 | n/a | n/a | 0.186 | 0.15 |

**Informative Note:** The Building Envelope Thermal Bridging Guide is available in an easy to navigate format at <https://thermalenvelope.ca/>.

## Amend C403.4 Heating and Cooling System Controls

Amend Section C403.4 as follows:

**C403.4 Heating and cooling system controls.**

Heating and cooling systems shall be provided with controls in accordance with Sections C403.4.1 through ~~C403.4.5~~C403.4.6.

**[…]**

**C403.4.6 Demand responsive controls.**

Buildings shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:

* 1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
  2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a *demand response signal* is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by *direct digital control* including, but not limited to, an energy management system, the system shall be capable of *demand responsive control* and capable of adjusting all thermal setpoints to comply. The demand responsive controls shall comply with either Section C403.4.6.1 or Section C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
3. Controls serving *data center systems*
4. Occupancies or applications requiring precision in indoor temperature control as *approved* by the *code official*
5. Controls that serve only fossil fuel equipment

**C403.4.6.1 Air conditioners and heat pumps with two or more stages of control and cooling capacity of less than 65,000 Btu/h. .**

Thermostats for Air conditioners and heat pumps with two or more stages of control and a cooling capacity less than 65,000 Btu/h (19 kW) shall be provided with a *demand responsive control* that complies with the communication and performance requirements of AHRI 1380.

**C403.4.6.2 All other HVAC systems.**

Thermostats for HVAC systems shall be provided with a *demand responsive control* that complies with one of the following:

1. Certified OpenADR 2.0a VEN, as specified under Clause 11, Conformance
2. Certified OpenADR 2.0b VEN, as specified under Clause 11, Conformance
3. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls
4. IEC 62746-10-1
5. The communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program
6. The physical configuration and communication protocol of CTA 2045-A or CTA 2045-B.

## Add C404.11 Demand Responsive Water Heating

Add Section C404.11 as follows:

**C404.11 Demand responsive water heating.**

Electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with *demand responsive controls* in accordance with Table C404.11 or another equivalent *approved* standard.

**Exceptions:**

* 1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
  2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
  3. Water heaters that use 3-phase electric power.

**TABLE C404.11** **DEMAND RESPONSIVE CONTROLS FOR WATER HEATING**

|  |  |  |
| --- | --- | --- |
| Equipment Type | Controls |  |
| Manufactured before 7/1/2025 | Manufactured on or after 7/1/2025 |
| Electric storage water heaters | ANSI/CTA-2045-B Level 1 and also capable of initiating water heating to meet the temperature set point in response to a *demand response signal*. | ANSI/CTA-2045-B Level 2, except “Price Stream Communication” functionality as defined in the standard. |

## Amendments to Section 403 Building Mechanical Systems

Add new Section C403.15 Dehumidification in spaces for plant growth and maintenance as follows:

**C403.15 Dehumidification in spaces for plant growth and maintenance.**

Equipment that dehumidifies *indoor grow* and *greenhouse* spaces shall be one or more of the following:

|  |
| --- |
| 1. *Dehumidifiers* tested in accordance with the test procedure listed in DOE 10 CFR 430 and DOE 10 CFR 430, Subpart B, Appendix X or X1. 2. *Integrated HVAC system* with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat; 3. Chilled water system with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat; or 4. Solid or liquid *desiccant dehumidification system* for system designs that require dewpoint of not more than 50°F (10°C).  Amend C405.2.7.2 Building Façade and Landscape Lighting Amend Section C405.2.7.2 as follows:  **C405.2.7.2 Building facade and landscape lighting.** Building facade and landscape lighting shall automatically shut off ~~from not later than 1 hour after business closing to not earlier than 1 hour before business opening.~~ at business closing, or midnight, whichever comes first, and shall remain off until the following evening. Amend C405.2.7.3 Lighting Setback Amend Section C405.2.7.3 as follows:  **C405.2.7.3 Lighting setback.** Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:   1. […] 2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 40 ~~78~~ watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.  Amendments to Section 405 Electrical Power and Lighting Systems Section C405.4 of the 2021 IECC Commercial Provisions shall be replaced in its entirety by a new section C405.4 as follows:  **C405.4 Horticultural lighting.**  Luminaires in *indoor grow* spaces and *greenhouse* spaces used for *horticultural lighting* shall have a *photosynthetic photon efficacy* (PPE) of at least 2.1 μmol/J. |

## Amend C405.5.3 Gas Lighting

Amend Section C405.5.3 as follows:

**C405.5.3 Gas lighting.** Gas-fired lighting appliances shall not be ~~equipped with continuously burning pilot ignition systems~~ installed.

## Amend C405.12 Energy Monitoring

Amend Section C405.12 as follows:

**C405.12 Energy monitoring.**

~~New buildings~~*Buildings* ~~with a gross conditioned floor area of 25,000 square feet (2322m~~~~2~~~~) or larger with a gross conditioned floor area of 25,000 square feet (2322 m2) or larger~~ shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exceptions:

1. Buildings less than 10,000 square feet (929 m2).

2. Existing buildings.

3. R-2 occupancies with less than 10,000 square feet (929 m2) of common area.

4. Individual tenant spaces ~~are not required to comply with this section provided that the space has its own utility services and meters and has~~ less than 5,000 square feet (464.5 m2) ~~of conditioned floor area with their own utility service and meter.~~

**TABLE C405.12.2** **ENERGY USE CATEGORIES**

|  |  |
| --- | --- |
| **LOAD CATEGORY** | **DESCRIPTION OF ENERGY USE** |
| *Electric vehicle* charging | Where connected to the *building* or *building site* electrical service, *electric vehicle* charging loads. |

## Addition of New Section C405.13 Electrical Readiness

Add New Section C405.13 Electrical Readiness as follows:

**C405.13 Electrical readiness.**

New buildings that use fossil fuel for space heating, water heating, or cooking shall comply with C405.13.1 and C405.13.2; and shall comply with C405.13.3 though C405.13.5, as applicable for the equipment or appliances that use fossil fuels.

**C405.13.1 Electrical capacity.**

The minimum service load for the building shall be calculated for the future installation of electric equipment and appliances in accordance with NFPA 70 and the following sections.

**C405.13.3 Space heating.**

**C405.13.3.1 Low-capacity heating.**

Locations of fossil fuel warm-air furnaces with a capacity less than 225,000 Btu/h (65.9 kW) or boilers with a capacity less than 300,000 Btu/h (87.9 kW) shall comply with the following:

* 1. An individual branch circuit shall be installed in compliance with NFPA 70 Section 424.4 based on heat pump space heating equipment sized in accordance with Section C403.3.1 of this code.
  2. The individual branch circuit shall terminate within 3 ft (1 m) of the location of the space heating equipment and be *readily accessible*.
  3. The points of origin and termination of the branch circuit shall be labeled, “For Future Heat Pump Space Heater” and be electrically isolated.

**Exception:** Where a circuit exists for dedicated cooling equipment with the capacity to serve heat pump space heating equipment in accordance with the requirements of Section 6.4.2 of ASHRAE 90.1

**C405.13.3.2 High-capacity heating.**

Locations containing space heating equipment not regulated by C405.13.3.1 that uses fossil fuels shall be provided with conduit that is continuous between a junction box located within 3 ft (1 m) of the equipment and an electrical panel. The junction box, conduit, and bus bar in the electrical panel shall be rated and sized to accommodate an individual branch circuit with sufficient capacity for electric equipment with an equivalent equipment capacity. The electrical panel shall have sufficient physical space for branch circuit overprotection devices sized to serve the designed electric heating equipment, The electrical junction box and electrical panel shall be labeled, “For Future Electric Space Heating Equipment.”

**C405.13.4 Water heating.**

**C405.13.4.1 Low-capacity water heating.**

1. Locations containing water heaters with a capacity less than 300,000 Btu/h (87.9 kW) shall be provided with a 208/240-volt individual branch circuit having a minimum 30-ampere capacity, shall terminate within 3 ft (1 m) from the water heater, and shall be accessible to the water heater with no obstructions. The points of origin and termination of the branch circuit shall be labeled, "For Future Heat Pump Water Heater" and be electrically isolated.
2. Locations containing water heaters with a capacity less than 300,000 Btu/h (87.9 kW) shall be a minimum height of 7 ft (2 m), width of 3 ft (1 m) and volume of 700 ft3 (20 m3).

**Exception:** Where the space containing the water heater is provided with air ducts or transfer openings to accommodate a heat pump water heater, the minimum volume shall not be required.

**C405.13.4.2 High-capacity water heating.**

1. Locations containing water heaters with a capacity greater than or equal to 300,000 Btu/h (87.9 kW) shall be provided with conduit that is continuous between a junction box located within 3 ft (1 m) of the equipment and an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate an individual branch circuit with sufficient capacity for electric equipment with an equivalent equipment capacity. The electrical junction box and electrical panel shall be labeled, “For Future Electric Water Heating Equipment”.
2. Locations containing water heaters with a capacity greater than or equal to 300,000 Btu/h (87.9 kW) shall be designed to accommodate the installation of a heat pump water heater system that can provide equivalent demand and supply capacity. The space shall support the structural design load of future equipment in accordance with BCNYS Chapter 16 and provide adequate space for installation. Design documents shall be provided that include future heat pump water heating system layout to building owner.

**C405.13.5 Appliances and other equipment.**

**C405.13.5.1 Cooking.** Locations containing cooking equipment that uses fossil fuels shall comply with this section based on the volume and frequency of cooking equipment use.

**C405.13.5.1.1 Light and medium duty cooking.** Light- and medium duty cooking equipment not designated as *commercial cooking appliances* shall be provided with an individual branch circuit in compliance with NFPA 70 Section 422.10. The branch circuit shall terminate within 6 ft (2 m) of fossil fuel appliances; and shall be accessible with no obstructions. The points of origin and termination of the branch circuit shall be labeled, “For Future Electric Cooking Equipment” and be electrically isolated.

**C405.13.5.1.2 Commercial cooking.** *Commercial cooking appliances* shall be provided with an individual branch circuit with a minimum capacity of 80VA per 1 kBtu/hr (76 VA per 1 MJ/hr) of appliance input capacity. The branch circuit shall terminate within 3 ft (1 m) of the appliance. The points of origin and termination of the branch circuit shall be labeled, “For Future Electric Cooking Equipment” and be electrically isolated.

**C405.13.5.2 Clothes drying.** Locations containing clothes drying equipment that uses fossil fuels shall comply with this section based on the occupancy served.

**C405.13.5.2.1 Residential drying.** Clothes drying equipment or appliances with a capacity less than or equal to 9.2 ft3 (0.26 m3) serving individual or multiple *dwelling units* shall be provided with an individual 240-volt branch circuit with a minimum capacity of 30 amperes. The circuit shall terminate within 6 ft (2 m) of fossil fuel clothes dryers and shall be accessible with no obstructions. The points of origin and termination of the branch circuit shall be labeled, “For Future Electric Clothes Drying Equipment” and be electrically isolated.

**C405.13.5.2.2 Commercial drying.** *Clothes drying equipment* not regulated by C405.13.5.2.1 shall be provided with conduit that is continuous between a junction box located within 3 ft (1 m) of the equipment and an electrical panel. The junction box, conduit, and bus bar in the electrical panel shall be rated and sized to accommodate an individual branch circuit with sufficient capacity for electric equipment with an equivalent equipment capacity. The electrical junction box and electrical panel shall be labeled, “For Future Electric Clothes Drying Equipment”.

**C405.13.5.3 Other equipment.** Appliances, equipment, and end-uses that use fossil fuels not specifically regulated by Section C405.13 shall be provided with an individual branch circuit sized for an electric appliance, equipment, or end use with an equivalent capacity that terminates within 6 feet of the equipment.

## Addition of New Section C405.14 Renewable Energy Systems

Add Section C405.14 Renewable Energy Systems as follows:

**C405.14 Renewable energy systems.** Buildings shall comply with C405.14.1 through C405.14.3.

**C405.14.1 On-site renewable energy systems.**

*Buildings shall comply with one of the following:*

*1. Buildings* shall have equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than 0.75 W/ft2 (8.1 W/m2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

*2. Buildings or building sites* complying with C405.15.1 shall be permitted to have equipment for on-site renewable energy generation with a direct current (DC) nameplate power rating of not less than 0.50 W/ft2 (6.0 W.m2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

**Exception to C405.14.1:** The following *buildings* or *building sites* shall comply with Section C405.14.2:

1. A *building site* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft2 - day (3.5 kWh/m2- day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any *building* where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m2).

Direct-current-to-alternating-current inverters serving on-site renewable energy systems or on-site electrical energy storage systems shall be compliant with IEEE 1547-2018a and UL 1741-2021.

**C405.14.2 Off-site renewable energy.** *Buildings* that qualify for one or more of the exceptions to Section 405.14.1 and do not meet the requirements of Section 405.14.1 either in part or in full, with an on-site renewable energy system, shall procure off-site renewable electrical energy, in accordance with C405.14.2.1 and C405.14.2.2, that shall be not less than the annual off-site renewable electrical energy (REoff) determined as follows:

**REoff** =(REtotal - REon-site)\*1.25

REtotal=ARE\*0.75W/ft2\*FLRA

REon-site=ARE\*ORSR

Where:

REtotal= total required annual renewable electrical energy in kilowatt-hours (kWh)

REon-site = annual renewable electrical energy of the specified on-site renewable system in kilowatt-hours (kWh)

REoff = renewable electrical energy in kilowatt-hours (kWh) that must be procured annually for the minimum of 15 years

ARE = annual renewable energy generation (kWh) per Watt of DC nameplate power rating from Table C405.14.2

ORSR= specified on-site renewable system direct current (DC) nameplate power rating

FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors

1.25 = off-site renewable energy derating

**Table C405.14.2 Annual Renewable Energy Generation (kWh)**

|  |  |
| --- | --- |
| **Climate Zone** | **ARE** |
| CZ4a | 1.19 |
| CZ5a; CZ6a | 1.14 |

**C405.14.2.1 Off-site procurement.**

The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-12, with one or more of the following:

|  |  |
| --- | --- |
| 1. | A *physical renewable energy power purchase agreement* |
| 2. | A *financial renewable energy power purchase agreement* |
| 3. | A *community renewable energy facility* |
| 4. | Off-site renewable energy system owned by the building property owner |

**C405.14.2.2 Off-site contract.**

The renewable energy shall be delivered or credited to the *building site* under an energy contract with a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable electrical energy shall be procured in equal installments over the duration of the off-site contract.

**C405.14.3 Renewable energy certificate documentation.**

The property owner or owner's authorized agent shall demonstrate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.14.1 and C405.14.2 all of the following criteria for RECs and EACs shall be met:

|  |  |
| --- | --- |
| 1. | Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the  duration of the contract in C405.14.2.2 whichever is less; |
| 2. | Are created within a 12-month period of the use of the REC; and |
| 3. | Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy. |

## Addition of New Section C405.15 Energy Storage Systems

Add Section C405.15 as follows:

**C405.15 Electrical energy storage system.**

Buildings shall comply with C405.15.1 or C405.15.2.

**C405.15.1 Electrical energy storage energy capacity.**

Each building shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

|  |  |
| --- | --- |
| 1. | ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kWDC) |
| 2. | ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kWDC) |

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

**C405.15.2 Electrical energy storage system ready.**

Each building shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

|  |  |
| --- | --- |
| 1. | Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three  largest stories (ft2) x 0.0008 kWh/ft2 |
| 2. | Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest  stories (ft2) x 0.0002 kWh/ft2 |

**C405.15.2.1 ESS-ready location.**

Each ESS-ready area shall be located in accordance with Section 1207 of the *International Fire Code*.

**C405.15.2.2 ESS-ready minimum area requirements.**

Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 or UL9540A designated rating of the planned system. Where rated to UL9540A, the area shall be in accordance with the manufacturer's instructions.

**C405.15.2.3 Electrical distribution equipment.**

The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the criteria of Section C405.15.2.

## Addition of New Section C405.16 Electric Vehicle Systems

Add Section C405.16 as follows:

**C405.16 Electric Vehicle Power Transfer Infrastructure.**

New parking facilities shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections C405.16.1 through C405.16.6.

**C405.16.1 Quantity.**

The number of required *EV spaces*, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this Section and Table C405.16.1 based on the total number of *automobile parking spaces* and shall be rounded up to the nearest whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed *EVSE* spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV ready spaces* and *EV capable spaces*.
4. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV capable spaces*.
5. Where the number of *EV ready spaces* allocated for R-2 occupancies is equal to the number of dwelling units or to the number of *automobile parking spaces* allocated to R-2 occupancies, whichever is less, requirements for *EVSE spaces* for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.16.1 shall be used.

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

**Table C405.16.1** **REQUIRED EV POWER TRANSFER INFRASTRUCTURE**

|  |  |  |  |
| --- | --- | --- | --- |
| OCCUPANCY | *EVSE SPACES* | *EV READY SPACES* | *EV CAPABLE SPACES* |
| GROUP A | 10% | 0% | 10% |
| GROUP B | 15% | 0% | 30% |
| GROUP E | 2% | 0% | 5% |
| GROUP F | 2% | 0% | 5% |
| GROUP H | 1% | 0% | 0% |
| GROUP I | 2% | 0% | 5% |
| GROUP M | 10% | 0% | 10% |
| GROUP R-1 | 20% | 5% | 75% |
| GROUP R-2 | 20% | 5% | 75% |
| GROUP R-3 AND R-4 | 2% | 0% | 5% |
| GROUP S exclusive of parking garages | 1% | 0% | 0% |
| GROUP S-2 parking garages | 1% | 0% | 0% |

**C405.16.2 EV Capable Spaces.**

Each *EV capable space* used to meet the requirements of Section C405.16.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with C405.16.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each *EV capable space*.

**C405.16.3 EV Ready Spaces.**

Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.16.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum circuit capacity in accordance with C405.16.5.
3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

**C405.16.4 EVSE Spaces.**

An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section C405.16.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.16.5.
2. Have a minimum charging rate in accordance with C405.16.4.1.
3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section C405.16.6.

**C405.16.4.1 EVSE Minimum Charging Rate.**

Each installed *EVSE* shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charging each *EVSE space* at a minimum rate of no less than 3.3 kVA.
3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.16.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

**C405.16.5 Circuit Capacity.** The capacity of electrical infrastructure serving each *EV capable space*, *EV ready space*, and *EVSE space* shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* it serves.
2. The requirements of C405.16.5.1

**C405.16.5.1 Circuit Capacity Management.** The capacity of each branch circuit serving multiple *EVSE spaces*, *EV ready spaces*, or *EV capable spaces* designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE space* for R-2 occupancies when all (100%) of the *automobile parking spaces* designated for R-2 occupancies are designed to be *EV ready spaces* or *EVSE spaces*.
3. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE spaces* for a building site when all (100%) of the *automobile parking spaces* are designed to be *EV ready* or *EVSE spaces*.

**C405.16.6 EVSE Installation.** *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

## Addition of New Section C405.17 Grid Integration Systems

***Reserved***

## Amendments to Section C406 Additional Efficiency Requirements

Section C406 of the IECC 2021 Commercial Provisions shall be replaced in its entirety by a new section C406 as follows:

**SECTION C406**

**ADDITIONAL EFFICIENCY REQUIREMENTS**

**C406.1 Compliance**

New buildings shall comply with the requirements of Section C406.1.1. and core and shell buildings shall comply with C406.1.1.1.

**C406.1.1 Energy efficiency credit requirements.**

Buildings shall comply with measures from C406.2 to achieve the minimum number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Buildings with multiple *occupancies* and unconditioned parking garages shall comply as follows:

1. Where a building contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average energy credits required.
2. Unconditioned parking garages shall achieve half the credits required for use groups S-1 and S-2 in Table C406.1.1.

**Exceptions to C406.1.1:**

1. Buildings or portions of buildings that meet the requirements of C402.1.1 or C402.1.2.
2. Group F occupancies within buildings.
3. Buildings 7 stories or more above grade in R-2, R-4 and I-1 occupancy groups with no onsite combustion equipment for fossil fuel use in space heating and water heating, and that provides the code official with either a PHIUS Certification Letter from a PHIUS Certified Passive House Consultant or a PHI Certificate from a PHI Certified Passive House Consultant prior to the issuance of a certificate of occupancy.

**Table C406.1.1 Energy Credit Requirements by Building Occupancy Group**

|  |  |  |  |
| --- | --- | --- | --- |
| **Building Occupancy Group** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| R-2, R-4,  and I-1 | 147 | 129 | 129 |
| I-2 | 104 | 107 | 119 |
| R-1 | 80 | 71 | 80 |
| B | 84 | 85 | 89 |
| A-2 | 61 | 64 | 72 |
| M | 86 | 88 | 91 |
| E | 102 | 113 | 142 |
| S-1 and S-2 | 100 | 97 | 100 |
| All Other | 57 | 57 | 61 |

**C406.1.1.1 Building Core/Shell and Initial Build-Out Construction**

Where separate permits are used for *building* core/shell and initial build-out construction compliance shall be in accordance with the following requirements.

1. Core and shell *buildings* or portions of *buildings* shall comply with one of the following:
   1. Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1.1 in accordance with Section C406.2.
   2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.1.1.
2. For core and shell *buildings* or portions of *buildings* the energy credits achieved shall be subject to the following adjustments:
   1. Lighting measure credits shall be determined only for areas with final lighting installed.
   2. WhereHVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved
   3. WhereHVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed
3. Build-out construction shall be deemed to comply with Section C406.1 where either:
   1. Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1
   2. Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.1

**C406.1.2 Base and Measure Energy Credits**

Credits are available for the measures listed in Section C406.2. Base energy credits (abbreviated as BEC in formulas) for each measure are shown in Tables C406.1.3(1) through C406.1.3(9) based on building occupancies and climate zones. Base energy credits shall be modified, where applicable, to achieve measure energy credits (abbreviated as MEC in formulas) for the measure. Measure energy credits achieved shall be determined in one of three ways, depending on the measure:

1. The measure energy credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the measure description in Section C406.2.
2. The measure energy credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the measure description in Section C406.2. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.
3. The measure energy credit shall be by direct formula as stated in the measure description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

The sum of measure energy credits for individual measures included in the building shall count towards the total energy credits for the building*.*

**Table C406.1.3(1) Base Energy Credits for Group R-2, R-4, and I-1 Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 12 | 14 | 16 |
| H02 | Heating efficiency | C406.2.2.2 | 5 | 9 | 13 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H04 | Residential HVAC control | C406.2.2.4 | 19 | 21 | 19 |
| H05 | DOAS/fan control | C406.2.2.5 | 38 | 50 | 66 |
| H06 | Cold-Climate Heat Pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 120 | 98 | 100 |
| W02 | Heat pump water heater | C406.2.3.1 b | 102 | 84 | 86 |
| W04 | SHW pipe insulation | C406.2.3.2 | 9 | 7 | 7 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 4 | 3 | 3 |
| W07 | SHW heat trace system | C406.2.3.3 c | 16 | 12 | 12 |
| W08 | SHW submeters | C406.2.3.4 | 22 | 18 | 18 |
| W09 | SHW distribution sizing | C406.2.3.5 | 87 | 71 | 73 |
| W10 | Shower heat recovery | C406.2.3.6 | 31 | 26 | 27 |
| P01 | Energy monitoring | C406.2.4 | 3 | 3 | 3 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 1 | 1 | 1 |
| L05 | Residential light control | C406.2.5.5 | 8 | 5 | 4 |
| L06 | Light power reduction | C406.2.5.7 | 1 | 1 | 1 |
| Q01 | Efficient elevator | C406.2.7.1 | 6 | 5 | 4 |
| Q04 | Fault detection | C406.2.7.4 | 3 | 2 | 3 |

**Table C406.1.3(2) Base Energy Credits for Group I-2 Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 17 | 17 | 19 |
| H02 | Heating efficiency | C406.2.2.2 | 6 | 7 | 10 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H04 | Residential HVAC control | C406.2.2.4 | 12 | 13 | 12 |
| H05 | DOAS/fan control | C406.2.2.5 | 44 | 50 | 59 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 5 | 5 | 5 |
| W02 | Heat pump water heater | C406.2.3.1 b | 3 | 3 | 3 |
| W04 | SHW pipe insulation | C406.2.3.2 | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 1 | 1 | 1 |
| W10 | Shower heat recovery | C406.2.3.6 | 1 | 1 | 1 |
| P01 | Energy monitoring | C406.2.4 | 3 | 3 | 3 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 5 | 4 | 4 |
| L05 | Residential light control | C406.2.5.5 | 9 | 8 | 7 |
| L06 | Light power reduction | C406.2.5.7 | 6 | 6 | 5 |
| Q01 | Efficient elevator | C406.2.7.1 | 2 | 1 | 1 |
| Q04 | Fault detection | C406.2.7.4 | 3 | 3 | 3 |

**Table C406.1.3(3) Base Energy Credits for Group R-1 Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 10 | 10 | 12 |
| H02 | Heating efficiency | C406.2.2.2 | 3 | 3 | 5 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H04 | Residential HVAC control | C406.2.2.4 | 19 | 19 | 17 |
| H05 | DOAS/fan control | C406.2.2.5 | 23 | 27 | 37 |
| H06 | Cold-Climate Heat Pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 30 | 26 | 28 |
| W02 | Heat pump water heater | C406.2.3.1 b | 25 | 22 | 24 |
| W04 | SHW pipe insulation | C406.2.3.2 | 4 | 3 | 3 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 6 | 5 | 5 |
| W09 | SHW distribution sizing | C406.2.3.5 | 22 | 19 | 21 |
| W10 | Shower heat recovery | C406.2.3.6 | 8 | 7 | 7 |
| P01 | Energy monitoring | C406.2.4 | 2 | 2 | 2 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 1 | 1 | 1 |
| L06 | Light power reduction | C406.2.5.7 | 1 | 1 | 1 |
| Q01 | Efficient elevator | C406.2.7.1 | 3 | 2 | 2 |
| Q04 | Fault detection | C406.2.7.4 | 2 | 1 | 2 |

**Table C406.1.3(4) Base Energy Credits for Group B Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 13 | 14 | 17 |
| H02 | Heating efficiency | C406.2.2.2 | 3 | 5 | 8 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H04 | Residential HVAC control | C406.2.2.4 | 6 | 8 | 10 |
| H05 | DOAS/fan control | C406.2.2.5 | 31 | 42 | 57 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 16 | 16 | 16 |
| W02 | Heat pump water heater | C406.2.3.1 b | 6 | 7 | 7 |
| W04 | SHW pipe insulation | C406.2.3.2 | 5 | 5 | 5 |
| W05 | Point of use water heaters | C406.2.3.3 a | 24 | 24 | 24 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 6 | 6 | 6 |
| P01 | Energy monitoring | C406.2.4 | 3 | 3 | 4 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 6 | 5 | 5 |
| L06 | Light power reduction | C406.2.5.7 | 8 | 7 | 6 |
| Q01 | Efficient elevator | C406.2.7.1 | 5 | 5 | 5 |
| Q04 | Fault detection | C406.2.7.4 | 2 | 3 | 3 |

**Table C406.1.3(5) Base Energy Credits for Group A-2 Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 14 | 16 | 20 |
| H02 | Heating efficiency | C406.2.2.2 | 10 | 15 | 19 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H05 | DOAS/fan control | C406.2.2.5 | 51 | 67 | 84 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 39 | 37 | 37 |
| W02 | Heat pump water heater | C406.2.3.1 b | 27 | 26 | 26 |
| W04 | SHW pipe insulation | C406.2.3.2 | 3 | 2 | 2 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 4 | 3 | 3 |
| P01 | Energy monitoring | C406.2.4 | 2 | 2 | 2 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 2 | 1 | 1 |
| ~~L03~~ | ~~Increase occp. sensor~~ | ~~C406.2.5.3~~ | ~~1~~ | ~~1~~ | ~~1~~ |
| ~~L04~~ | ~~Increase daylight area~~ | ~~C406.2.5.4~~ | ~~2~~ | ~~2~~ | ~~1~~ |
| L06 | Light power reduction | C406.2.5.7 | 2 | 2 | 1 |
| Q01 | Efficient elevator | C406.2.7.1 | 1 | x | x |
| Q02 | Commercial kitchen equip. | C406.2.7.2 | TBD | TBD | TBD |
| Q04 | Fault detection | C406.2.7.4 | 2 | 3 | 3 |

**Table C406.1.3(6) Base Energy Credits for Group M Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 24 | 27 | 29 |
| H02 | Heating efficiency | C406.2.2.2 | 17 | 23 | 27 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H05 | DOAS/fan control | C406.2.2.5 | 88 | 108 | 120 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 20 | 18 | 17 |
| W02 | Heat pump water heater | C406.2.3.1 b | 5 | 5 | 5 |
| W04 | SHW pipe insulation | C406.2.3.2 | 5 | 5 | 5 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 6 | 6 | 6 |
| P01 | Energy monitoring | C406.2.4 | 6 | 6 | 7 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 3 | 1 | 0 |
| L06 | Light power reduction | C406.2.5.7 | 5 | 3 | 2 |
| Q01 | Efficient elevator | C406.2.7.1 | 4 | 4 | 3 |
| Q04 | Fault detection | C406.2.7.4 | 5 | 5 | 6 |

**Table C406.1.3(7) Base Energy Credits for Group E Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 17 | 17 | 21 |
| H02 | Heating efficiency | C406.2.2.2 | 4 | 8 | 14 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
|  |  |  |  |  |  |
| H05 | DOAS/fan control | C406.2.2.5 | 38 | 51 | 71 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 13 | 15 | 15 |
| W02 | Heat pump water heater | C406.2.3.1 b | 9 | 10 | 11 |
| W04 | SHW pipe insulation | C406.2.3.2 | 1 | 1 | 1 |
| W05 | Point of use water heaters | C406.2.3.3 a | 5 | 5 | 5 |
| W07 | SHW heat trace system | C406.2.3.3 c | 1 | 1 | 1 |
| W10 | Shower heat recovery | C406.2.3.6 | 3 | 3 | 3 |
| P01 | Energy monitoring | C406.2.4 | 3 | 3 | 4 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 5 | 5 | 4 |
| L06 | Light power reduction | C406.2.5.7 | 7 | 6 | 6 |
| Q01 | Efficient elevator | C406.2.7.1 | 5 | 5 | 5 |
| Q04 | Fault detection | C406.2.7.4 | 3 | 3 | 4 |

**Table C406.1.3(8) Base Energy Credits for Group S-1 and S-2 Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 28 | 33 | 35 |
| H02 | Heating efficiency | C406.2.2.2 | 30 | 36 | 39 |
| H03 | Cooling efficiency | C406.2.2.3 | 1 | 1 | x |
| H05 | DOAS/fan control | C406.2.2.5 | 127 | 151 | 162 |
| W01 | SHW preheat recovery | C406.2.3.1 a | 5 | 4 | 3 |
| W02 | Heat pump water heater | C406.2.3.1 b | 1 | 1 | 1 |
| W04 | SHW pipe insulation | C406.2.3.2 | 2 | 1 | 1 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 2 | 2 | 2 |
| P01 | Energy monitoring | C406.2.4 | 9 | 9 | 11 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 9 | 6 | 6 |
| L06 | Light power reduction | C406.2.5.7 | 12 | 8 | 8 |
| Q01 | Efficient elevator | C406.2.7.1 | 15 | 11 | 9 |
| Q04 | Fault detection | C406.2.7.4 | 8 | 9 | 12 |

**Table C406.1.3(9) Base Energy Credits for Other Occupancies**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Energy Credit Title** | **Section** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| E01 | Envelope Performance | C406.2.1.1 | Determined in accordance with Section C406.2.1.1 | | |
| H01 | HVAC Performance (TSPR) | C406.2.2.1 | 17 | 19 | 21 |
| H02 | Heating efficiency | C406.2.2.2 | 10 | 13 | 17 |
| H04 | Residential HVAC control | C406.2.2.4 | 20 | 23 | 21 |
| H05 | DOAS/fan control | C406.2.2.5 | 55 | 68 | 82 |
| H06 | Cold-climate heat pump | C406.2.2.6 | TBD | TBD | TBD |
| W01 | SHW preheat recovery | C406.2.3.1 a | 31 | 27 | 28 |
| W02 | Heat pump water heater | C406.2.3.1 b | 22 | 20 | 20 |
| W04 | SHW pipe insulation | C406.2.3.2 | 4 | 3 | 3 |
| W05 | Point of use water heaters | C406.2.3.3 a | 15 | 15 | 15 |
| W06 | Thermostatic bal. valves | C406.2.3.3 b | 1 | 1 | 1 |
| W07 | SHW heat trace system | C406.2.3.3 c | 5 | 5 | 5 |
| W08 | SHW submeters | C406.2.3.4 | 22 | 18 | 18 |
| W09 | SHW distribution sizing | C406.2.3.5 | 55 | 45 | 47 |
| W10 | Shower heat recovery | C406.2.3.6 | 3 | 3 | 3 |
| P01 | Energy monitoring | C406.2.4 | 4 | 4 | 5 |
| L02 | Lighting dimming & tuning | C406.2.5.2 | 4 | 3 | 3 |
| L05 | Residential light control | C406.2.5.5 | 6 | 4 | 4 |
| L06 | Light power reduction | C406.2.5.7 | 5 | 4 | 4 |
| Q01 | Efficient elevator | C406.2.7.1 | 5 | 4 | 3 |
| Q04 | Fault detection | C406.2.7.4 | 4 | 4 | 5 |

**C406.2 Additional Energy Efficiency Credit Measures**

Each energy efficiency credit measure used to meet credit requirements for the building shall include efficiency that is greater than the energy efficiency required for the building type and configuration requirements in Sections C402 through C405. Measures installed in the building that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the credits listed for the measure and occupancy type in Tables C406.1.3(1) through C406.1.3(9) or where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the section calculations.

**C406.2.1 E01 Improved envelope performance 90.1 Appendix C**

To achieve this credit, building envelope measures shall be installed to improve the energy performance of the project. The allowable energy credits shall be determined as follows:

*E01 MEC* = 1000 × (EPFB – EPFP)/EPFB (Equation 4-13)

Where:

EPFB = *base envelope performance factor* calculated in accordance with ASHRAE 90.1-­2019 Appendix C. \*

EPFP = *proposed envelope performance factor* calculated in accordance with ASHRAE 90.1-2019 Appendix C.\*

\* Appendix C as amended by Part 2 of this document.

**C406.2.2 More Efficient HVAC Performance**

HVAC systems are permitted to achieve energy credits by meeting the requirements of any combination of C406.2.2.1 (TSPR) and C406.2.2.6 (CCHP); or any combination of C406.2.2.2 (H02) through C406.2.2.6 (H06).

Heating and cooling systemsshall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal- or part-load efficiencies including SEER and SEER2, EER/integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or Annual Fuel Utilization Efficiency (AFUE). Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the building, the improvement shall be the weighted average improvement based on individual system rated capacity.

**C406.2.2.1 H01 HVAC Total System Performance (TSPR).**

If all HVAC *s*ystems in the scope of 90.1-2019 (amended) Section J1.1.1 meet the minimum requirements of 90.1-2019 (amended) Section J2.1.1 and J2.1.2b, H01 energy credits shall be determined as follows:

1. For projects that follow Section J2.1.2.3, Prescriptive Compliance Path, the H01 credit shall be calculated using the following equation:

H01 MEC = 0.8 x H01 BEC x (ATSPR /ATotal)

Where:

H01 BEC = H01 energy credits from Table C406.1.4(1) through C406.1.4(9). For buildings that have multiple occupancies, H01 base energy credits shall be calculated as a weighted average based on gross conditioned floor area.

ATSPR = *gross conditioned floor area* served by the *systems* in the scope of 90.1 (amended) Section J1.1

ATotal = total *building* *gross conditioned floor area*

Areas served by systems claiming credits for TSPR (ATSPR) shall not be eligible for credits H02 through H05.

1. For projects that follow Section J2.1.4, Modeling-based Compliance Path, the H01 credit shall be calculated using the following equation:

H01 MEC = H01 BEC x (1+TSPR%/100) x ATSPR /ATotal

TSPR% = (*TSPR*p x MPF - *TSPR*r )/ *TSPR*r

Where:

TSPR% = Percentage by which TSPR of proposed design exceeds the minimum TSPR requirement. The value of TSPR% cannot exceed 20% for purposes of calculating H01 energy credits.

*TSPR*p = proposed *TSPR* calculated in accordance with 90.1-2019 (amended) Section J2.1.5 and the requirements of Sections J2, J3, J4

*TSPR*r *R = reference TSPR* calculated in accordance with 90.1-2019 (amended) Section J2.1.5 and the requirements of Sections J2, J3 and J4.

MPF = mechanical performance factor calculated in accordance with 90.1-2019 (amended) Section J2.1.2.2.

*Systems* documenting compliance with H01 are not eligible for energy credits from HVAC measures H02, H03, H04 and H05

**C406.2.2.2 H02 More efficient space heating equipment performance**

For *buildings* not pursuing H01, no less than 90 percent of the total space heating capacity serving the total *conditioned floor area* of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section. For *buildings* pursuing H01 for the qualified *systems*, energy credits for heating efficiency improvement shall be prorated based on *conditioned floor area* as shown in Equation 4-14 and apply to no less than 90% of the total space heating capacity excluded from H01. No heating equipment shall use fossil fuel sources to claim this credit.

Buildings are eligible for both H01 and H02 measure energy credits only if the systems and building areas claiming H01 credit are separate from the systems and building areas claiming H02 credit.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2 for air-to-water heat pumps. Electric resistance heating that is not heat pump supplemental heating shall be limited to 20 percent of total system capacity applicable under H02. Equipment shall exceed the applicable minimum heating efficiency requirement listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum rated heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-14 rounded to the nearest whole number.

H02 MEC = H02 BEC × HEI/ 5% x (1-ATSPR /ATotal) (Equation 4-14)

Where:

HEI = the lesser of the improvement above minimum rated heating efficiency requirements or 20 percent. The heating efficiency metric is HSPF (heating seasonal performance factor) for split and packaged heat pumps and packaged terminal heat pumps with nominal capacity less than 65,000 Btu/h and COPH for heat pumps with nominal capacity of 65,000 Btu/h or greater.

ATSPR = *gross conditioned floor area* served by the *systems* in the scope of ASHRAE 90.1-2019 (as amended by Part 2 of this document) ~~Section 6.6.1~~ Appendix J and claiming H01 credit

ATotal = total *building* *gross conditioned floor area*

**C406.2.2.3 H03 More efficient space cooling equipment and fan performance.**

1. For *buildings* not pursuing H01, no less than 90 percent of the total space cooling capacity serving the total *conditioned floor area* of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section. For *buildings* pursuing H01 for the qualified *systems*, energy credits for cooling efficiency improvement shall be prorated based on *conditioned floor area* as shown in Equation 4-15 and apply to no less than 90% of the total space ~~heating~~ cooling capacity excluded from H01. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2
2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment classes have multiple ratings, the seasonal or part-load efficiency rating (SEER2, IEER) must exceed the minimum requirement by 5%, and the full-load efficiency rating (EER) must exceed minimum requirements. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-15, rounded to the nearest whole number.
3. Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or brake horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1

H03 MEC = H03 BEC × CEI/5% x (1-ATSPR /ATotal) (Equation 4-15)

Where:

CEI = the lesser of the improvement above minimum cooling and heat rejection efficiency requirements, or 50 percent. For buildings with multiple equipment and varied efficiency levels, this efficiency improvement is the capacity-weighted average efficiency improvement over the requirements in C403.3.2. Air-to-water heat pumps shall have an assumed efficiency improvement of 5% over standard efficiency levels of C403.3.2 for the purpose of this credit.

ATSPR = *gross conditioned floor area* served by the *systems* in the scope of ASHRAE 90.1-2019 (as amended by Part 2 of this document) Appendix J ~~Section 6.6.1~~ and claiming H01 credit

ATotal = total *building* *gross conditioned floor area*

**C406.2.2.4 H04 Residential HVAC control.**

For R-2, R-4, I-1 and I-2 occupancies, HVAC systems serving *dwelling units* or *sleeping units* shall be controlled with a programmable thermostat that is configured to automatically activate a setback condition of at least 5°F (3°C) for both heating and cooling. The programmable thermostat shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each *dwelling unit* main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identified as “Heating/Cooling Master Setback.”
2. Occupancy sensors in each room of the *dwelling unit* combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. A smart thermostat that senses occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic fencing connected to the dwelling unit occupants’ cell phones and initiates the setback condition when all occupants are away from the building.

**C406.2.2.5 H05 Dedicated Outdoor Air System**

Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. *DOAS* systems shall include all of the following:

1. Zone controls shall cycle the indoor fans with the load. Packaged units that provide cooling and/or heating but no ventilation shall cycle the supply fans with the load.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide no more than 110% of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code.*
3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65% or more at heating design conditions Energy recovery shall include latent recovery.
4. Where the ventilation system serves multiple zones, an outdoor air bypass or wheel speed control shall automatically do one of the following:
5. Set the energy recovery leaving-air temperature of 60°F or lower, (13°C) or enable 100% outdoor air bypass (wheel speed control not permitted) when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).
6. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.
7. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat.

Systems pursuing H01 energy credits do not qualify for H05 credit. The base energy credits shown in Tables C406.1.3(1) through C406.1.3(9) shall be prorated proportionately to the *conditioned floor area* served by single zone constant-volume HVAC units per Equation 4-15.

H05 MEC = H05 BEC x CFA-DOAS / CFA-TOTAL (Equation 4-15)

Where:

CFA-DOAS = Conditioned Floor Area of all spaces served by DOAS units that also use single-zone, constant-volume systems meeting the criteria in Table C403.8.6.1 for space conditioning

CFA-Total = Total Conditioned Floor Area of the Building

**C406.2.2.6 H06 Cold-Climate Heat Pumps (CCHP)**

To achieve this credit, at least 90% of the total installed space heating capacity shall be met by air-source cold-climate heat pumps meeting the following minimum requirements of the Northwest Energy Efficiency Partnerships (NEEP)) asCCHP Specification, Version 3.1:

* 1. For Non-Ducted systems: HSPF >10
  2. For Ducted systems: HSPF >9
  3. COP at 5°F >1.75 (at maximum capacity operation)
  4. SEER > 15

**C406.2.3 Reduced Energy Use In Service Water Heating**

Buildings with service water-heating equipment that serves an entire newly constructed building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of one or more of the following items:

1. C406.2.3.1 by selecting no more than one allowed measure W01, W02
2. C406.2.3.2 W04
3. C406.2.3.3 by selecting no more than one allowed measure W05, W06, or W07
4. C406.2.3.4 W08
5. C406.2.3.5 W09
6. C406.2.3.6 W10

**C406.2.3.1 Service water-heating system efficiency**

A building is allowed to claim energy credits from only one of the following water-heating system efficiency measures.

1. **W01 Recovered or renewable water heating.** The building service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the building’s annual hot water requirements or sized to provide 70 percent of the building’s annual hot water requirements if the building is required to comply with Section C403.10.5:
2. Waste heat recovery from ~~SHW,~~ heat recovery chillers, building equipment, or process equipment.
3. A water-to-water heat pump that precools chilled water return for building cooling.
4. On-site renewable energy water-heating systems.
5. **W02 Heat pump water heater:** To achieve this credit, air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior. Any recirculating system and auxiliary water heating system shall be met with a separate heating source from the heat~~ing~~ pump water heater. Requirements shall be in accordance with one of the following:
6. For multifamily, dormitories, and health care occupancies with a *recirculating system*, at least 30% of design end-use *service water-heating* requirements shall be met using heat pump preheat with a coefficient of performance (COP) of not less than 4.0 tested at 50°F (10°C) entering air and 70°F (21°C) entering water in accordance with AHRI Standard 1300. A preheat storage tank equal to 25% of peak demand shall be included in design.
7. For office, restaurant and school *occupancies* with *piping* temperature maintenance, at least 30% of design end-use *service water-heating* requirements shall be met using heat pump preheat with a combined input-capacity-weighted-average uniform energy factor (UEF) of 3.0 with a medium draw pattern for unitary *equipment* with either a *heat trace system* or a separate *water heater* in series for *recirculating system* and final heating.
8. For retail, ~~small~~ office, and warehouse *occupancies* with no *recirculating system*, at least 30% of design end-use *service water-heating* requirements shall be met using the heat pump portion of a hybrid *water heater* with a combined input-capacity-weighted-average UEF of 3.0 with a medium draw pattern for unitary *equipment*, including *electric resistance* heating to meet peak loading.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50% of the design end-use service water heating load excluding *recirculating system* losses, the base credits from the Section C406.1 Tables C406.1.3(1) through C406.1.3(9) shall be prorated based on Equation 4-16.

W02 MEC = W02 BEC × HPLF/50% (Equation 4-16)

HPLF = Heat pump rated heating capacity at 50°F (10°C) entering air and 70°F (21°C) entering water as a fraction of the design end-use service water-heating capacity, excluding recirculating system losses, not to exceed 80%.

**C406.2.3.2 W04 Water-heating pipe insulation.**

To achieve this credit, where SHW is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Table C403.12.3. All SHW piping shall be insulated from the hot water source to the fixture shutoff. For Group S (warehouse and storage) and Group M (retail) occupancies, this measure is only available where a recirculation or heat trace system is used and piping length exceeds 80 linear feet.

**C406.2.3.3 Water-heating distribution temperature maintenance**

A SHW system is allowed to claim energy credits from no more than one of the following SHW distribution temperature maintenance measures.

1. **W05 Point of use water heaters**. Credits are available for office or school buildings larger than 10,000 ft2 (930 m2). Buildings that use recirculating water heating systems or heat trace are not eligible for this credit. Separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:
2. Non-residential lavatories: not more than 2 oz (60 mL)
3. All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)
4. **W06 Thermostatic balancing valves.** Credits are available where service water heating is provided centrally and distributed throughout the building. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 115°F (46°C).
5. **W07 Heat trace system.** Credits are available for buildings with gross floor area greater than 10,000 square feet and a central water heating system. This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

**C406.2.3.4 W08 Water-heating system submeters**

To achieve this credit, each individual *dwelling unit* served by a central service water heating system shall be provided with a meter connected to a reporting system that provides individual *dwelling unit* reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered. Where other codes or regulations require individual *dwelling unit* hot water metering, energy credits for this measure shall not be allowed.

**C406.2.3.5 W09 Water heating distribution sizing**

To achieve this credit, where Group R-1 and R-2 occupancies are served by a central service water heating system, the distribution system serving dwelling units and guest rooms shall be sized using IAPMO/ANSI WE●Stand – 2017 Water Efficiency and Sanitation Standard for the Built Environment. Plumbing fixtures in residential spaces that are connected to the service water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5. Where other codes or regulations require fixture flows to be equal to or less than listed in Table C406.2.3.5 only half the base energy credits shall be achieved for this measure.

**Table C406.2.3.5 Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water**

|  |  |
| --- | --- |
| **Plumbing Fixture** | **Maximum Flow Rate** |
| Faucet for private lavatory,a hand sinks, or bar sinks | 1.50 gpm at 60 psi (0.095 L/s at 410 kPa) |
| Faucet for residential kitchen sink a, b, c | 1.8 gpm at 60 psi 0.11 L/s at 410 kPa) |
| Shower head (including hand-held shower spray) a, b, d | 2.0 gpm at 80 psi (0.13 L/s at 550 kPa) |

*a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)-(p).*

*b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.*

*c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.*

*d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.*

***Informative Note:*** *Where low water supply pressures are anticipated, user satisfaction may be enhanced if flow restrictors are specified to provide ≥80% of the rated flow at 20 psi (140 kPa). Where the distribution sizing protocol is applied to other than multifamily residential buildings, a variance to the plumbing code may be needed.*

**C406.2.3.6 W10 Shower drain heat recovery**

To achieve this credit, cold water serving building showers shall be preheated by shower drain heat recovery units that comply with CSA B55.2. Potable waterside pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. The efficiency of drain heat recovery units shall be 54% or greater measured in accordance with CSA B55.1. Full credits are applicable to the following building use types: health clinic, hospital, hotel, motel, multifamily, retirement facility, dormitory, and schools with more than eight showers. Partial credits are applicable to buildings where all but ground floor showers are served. Partial credit shall be calculated by adjusting the base energy credit from Tables C406.1.3(1) through C406.1.3(9) using Equation 4-17.

W10 MEC = W10 BEC x showers-with-DWHR / total-num-showers (Equation 4-17)

Where:

Showers-with-DHWR = the number of showers with drain water heat recovery

Tptal-num-showers = the total number of showers in the building

**C406.2.4 P01 Energy Monitoring**

A building not required to comply with C405.12 can claim energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.5.

**C406.2.5 Energy Savings in Lighting Systems**

Buildings are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of measures L02 through L06. Any combination of measures L02 through L06 is allowed, except the combination of measure L02 and measure L06. ANSI/IES Recommended Practice for the space occupancy shall be followed to ensure sufficient illumination is provided.

**C406.2.5.1 *(Reserved)***

**C406.2.5.2 L02 Enhanced digital lighting controls.**

Projects are eligible for L02 credits if no less than 50 percent of the gross floor area within the building complies with the requirements of this section.

1. Lighting controls function. Interior general lighting shall be located, scheduled, and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:
2. Luminaires shall be configured for continuous dimming.
3. Each luminaire shall be individually addressed.

**Exceptions to 1b:**

1. Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.
2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet.
3. No more than eight luminaires within a *daylight zone* are permitted to be controlled by a single *daylight responsive control*.
4. Luminaires shall be controlled by a digital control system configured with the following capabilities:
5. Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.
6. Load shedding.
7. In open and enclosed offices, the illumination level of overhead general illumination luminaires are configured to be individually adjusted by occupants.
8. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.
9. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.
10. High-end trim.Luminaires shall be initially configured with the following:
11. High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.
12. Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.
13. High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.

Where *general lighting* in more than 50 percent of the *gross lighted floor area* receives *high-end trim*, the base credits from Tables C406.1.3(1) through C406.1.3(9) shall be prorated as follows:

L02 MEC = [Tuned lighted floor area,%] × [L02 BEC] / 50%

Where:

Tuned lighted floor area, % = the percentage of floor area where all lighting complies with all of the requirements of W02.

**C406.2.5.3 L03 *Reserved***

**C406.2.5.4 L04 *Reserved***

**C406.2.5.5 L05 Residential light control**

To achieve this credit, dwelling unit lighting systems shall comply with all of the following:

1. Each *dwelling unit* shall have a main control by the main entrance that turns off all the lights and all switched receptacles in the *dwelling unit*.
2. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles.
3. Where controls are divided ~~T~~the main controls ~~should~~ shall be clearly identified as “lights master off” and “outlets master off.”

**C406.2.5.6 L06 Reduced lighting power.**

To achieve these credits, all of the Interior lighting shall comply with all the requirements of this section. In Group R occupancies the credit is calculated for all common areas other than dwelling units and sleeping units as long as no less than 95 percent of the permanently installed light fixtures in dwelling units and sleeping units shall be provided by high-efficacy lamps with a minimum efficacy of 90 lumens per Watt.

For occupancies other than Group R, ~~The~~ the ~~net~~ total connected interior lighting power (LPn) shall be 95% or less than the ~~net interior~~ lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. Energy credits shall be determined based on one of the following:

1. Where LPn ≤ 80% of LPAn, ~~the building shall achieve four times the C406.2.5.6 credits from Tables C406.1.3(1) through C406.1.3(9).~~ energy credits shall be determined using Equation 4-20.

ECLPA = EC5\*4 (Equation 4-20)

1. Where LPn > 80% of LPAn and LPn ≤ 95% of LPAn energy credits shall be determined using Equation 4-20.

L06 MEC = L06 BEC x 20 x (LPAn – LPn) / LPAn (Equation 4-20)

Where:

~~ECLPA = additional energy credit for lighting power reduction~~

LPn = net total connected interior lighting power calculated in accordance with Section C405.3.1, watts, less any additional lighting power allowed in Section C405.3.2.2.1

LPAn = interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1

~~EC~~~~5~~~~= L06 base credit from Tables C406.1.3(1) through C406.1.3(9)~~

**C406.2.7 Efficient Equipment Credits**

**C406.2.7.1 Q01 Efficient Elevator and Escalator Equipment**

Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-22, rounded to the nearest whole credit. At least 50% of the building’s floors must be served by Class A elevators to be eligible for this credit.

Q01 MEC = Q01 BEC × FA/FB (Equation 4-22)

Where:

FA = Sum of floors served by class A elevators

FB = Sum of floors served by all building elevators and escalators

**C406.2.7.2 Q02 Efficient Commercial Kitchen Equipment.**

For buildings and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen with at least one gas or electric fryer, all fryers, dishwashers, steam cookers and ovens shall comply with all of the following:

1. Achieve performance levels in accordance with the equipment specifications listed in Tables C406.12 (1) through C406.12 (4) when rated in accordance with the applicable test procedure.
2. Be installed before the issuance of the Certificate of Occupancy.
3. Have associated performance levels listed on the construction documents submitted for permitting.

**Table C406.2.7.2 (1) Minimum Efficiency Requirements: Commercial Fryers**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Heavy-Load**  **Cooking Energy**  **Efficiency** | **Idle Energy**  **Rate** | **Test Procedure** |
| Standard Open Deep-Fat Gas Fryers | ≥ 50% | ≤ 9,000 Btu/hr | ASTM F1361 |
| Standard Open Deep-Fat Electric  Fryers | ≥ 83% | ≤ 800 watts |
| Large Vat Open Deep-Fat Gas Fryers | ≥ 50% | ≤ 12,000 Btu/hr | ASTM F2144 |
| Large Vat Open Deep-Fat Electric  Fryers | ≥ 80% | ≤ 1,100 watts |

For SI: BTU/h = 0.293W

**Table C406.2.7.2 (2) Minimum Efficiency Requirements: Commercial Steam Cookers**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fuel Type** | **Pan Capacity** | **Cooking Energy Efficiencya** | **Idle Energy**  **Rate** | **Test Procedure** |
| Electric Steam | 3-pan | 50% | 400 watts | ASTM F1484 |
| 4-pan | 50% | 530 watts |
| 5-pan | 50% | 670 watts |
| 6-pan and larger | 50% | 800 watts |
| Gas Steam | 3-pan | 38% | 6,250 Btu/h |
| 4-pan | 38% | 8,350 Btu/h |
| 5-pan | 38% | 10,400 Btu/h |
| 6-pan and larger | 38% | 12,500 Btu/h |

a. Cooking Energy Efficiency is based on heavy-load (potato) cooking capacity

**Table C406.2.7.2 (3) Minimum Efficiency Requirements: Commercial Dishwashers**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Machine**  **Type** | **High Temperature Efficiency**  **Requirements** | | **Low Temperature Efficiency**  **Requirements** | | **Test**  **Procedure** |
|  | **Idle Energy**  **Ratea** | **Water**  **Consumptionb** | **Idle Energy**  **Ratea** | **Water**  **Consumptionb** |  |
| Under  Counter | ≤ 0.50 kW | ≤ 0.86 GPR | ≤ 0.50 kW | ≤ 1.19 GPR | ASTM F1696 |
| Stationary  Single Tank  Door | ≤ 0.70 kW | ≤ 0.89 GPR | ≤ 0.60 kW | ≤ 1.18 GPR |
| Pot, Pan,  and Utensil | ≤ 1.20 kW | ≤ 0.58 GPR | ≤ 1.00 kW | ≤ 0.58 GPSF |
| Single Tank  Conveyor | ≤ 1.50 kW | ≤ 0.70 GPR | ≤ 1.50 kW | ≤ 0.79 GPR | ASTM F1920 |
| Multiple  Tank  Conveyor | ≤ 2.25 kW | ≤ 0.54 GPR | ≤ 2.00 kW | ≤ 0.54 GPR |
| Single Tank  Flight Type | Reported | GPH ≤ 2.975x +  55.00 | Reported | GPH ≤ 2.975x +  55.00 |
| Multiple  Tank Flight  Type | Reported | GPH ≤ 4.96x +  17.00 | Reported | GPH ≤ 4.96x +  17.00 |

1. Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. Booster heater (internal or external) energy consumption shall not be part of this measurement unless it cannot be separately monitored per US EPA Energy Star Commercial Dishwasher Specification Version 2.0.
2. GPR = gallons per rack, GPSF = gallons per square foot of rack, GPH = gallons per hour, x = sf of conveyer belt (i.e., W\*L)/min (maximum conveyor speed)

**Table C406.2.7.2 (4) Minimum Efficiency Requirements: Commercial Ovens**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fuel Type** | **Classification** | **Idle Rate** | **Cooking Energy Efficiency,**  **%** | **Test Procedure** |
| **Convection Ovens** | | | | |
| Gas | Full-Size | ≤ 12,000 Btu/h | ≥ 46 | ASTM F1496 |
| Electric | Half-Size | ≤ 1.0 Btu/h | ≥ 71 |
| Full-Size | ≤ 1.60 Btu/h |
| **Combination Ovens** | | | | |
| Gas | Steam Mode | ≤ 200Pa + 6,511 Btu/h | ≥ 41 | ASTM F2861 |
| Convection  Mode | ≤ 150Pa + 5,425 Btu/h | ≥ 56 |
| Electric | Steam Mode | ≤ 0.133Pa + 0.6400 kW | ≥ 55 |
| Convection  Mode | ≤ 0.080Pa + 0.4989 kW | ≥ 76 |
| **Rack Ovens** | | | | |
| Gas | Single | ≤ 25,000 Btu/h | ≥ 48 | ASTM F2093 |
| Double | ≤ 30,000 Btu/h | ≥ 52 |

P = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

**C406.2.7.~~4~~3 Q04 Fault detection and diagnostics system.**

A building not required to comply with C403.2.3 can claim energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

## Delete Section C407 Total Building Performance

Section C407 of the IECC 2021 Commercial Provisions shall be deleted.

**~~Section C407 Total Building Performance~~**

## Amendments to Section C502.3 Compliance

Section C502.3 of the IECC 2021 Commercial Provisions shall be amended to read as follows:

*Additions* shall comply with Sections C502.3.1 through ~~C502.3.6.2~~ C502.3.7.

## Addition of New Section C502.3.7 Additional energy efficiency credits

Section C502.3 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C502.3.7 as follows:

**C502.3.7 Additional energy efficiency credits.**

*Additions* shall comply with measures from Sections C406.2 to achieve not less than 50 percent of the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Credits shall be achieved from Tables C406.1.3(1) through C406.1.3(9) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, shall be permitted to be used to achieve the required credits.

Exceptions:

1. Buildings in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H
2. Additions less than 1,000 ft2 and less than 50% of existing floor area.
3. Additions that do not include the addition or replacement of equipment covered in Section C403.3 or C404.2

4. Additions that do not contain conditioned space

## Addition of New Section C503.3.2 Replacement System Sizing

Section C503.3 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C503.3.2 as follows:

**C503.3.2 System sizing.**

New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section C403.1.1 based on the existing *building* features as modified by the *alteration*.

**Exception:**

Where is has been demonstrated to the code official that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.

## Addition of New Section C503.3.3 Mechanical systems acceptance testing

Section C503.3 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C503.3.3 as follows:

**C503.3.3 Mechanical system acceptance testing.** Where an *alteration* requires compliance with Section C403 or any of its subsections, mechanical systems that serve the *alteration* shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

**Exceptions:**

* + 1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than a combined heating, cooling, and service water-heating capacity of less than 960,000 Btu/h (280 kW).
    2. Systems included in Section C403 that serve individual *dwelling units* and *sleeping units*.

## Addition of New Section C503.3.4 Controls

Section C503.3 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C503.3.4 as follows:

**C503.3.4 Controls.**

New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section C403.4.

**Exception:**

Systems with direct digital control of individual zones reporting to a central control panel.

## Addition of New Section C503.4.1 Service hot water system acceptance testing

Section C503.3 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C503.4.1 as follows:

**C503.4.1 Service hot water system acceptance testing.** Where an *alteration* requires compliance with Section C404 or any of its subsections, service hot water systems that serve the *alteration* shall comply with Sections C408.2.3 and C408.2.5.

**Exceptions:**

1. Service water heater systems in buildings where the combined heating, cooling, and service water-heating capacity is less than 960,000 Btu/h (280 kW).
2. Systems included in Section C404 that serve individual dwelling units and sleeping units
3. Central systems and plants where it has been demonstrated to the *code official* that the central system or plant has met the requirements of this section within the previous five years.

## Addition of New Section C503.5.1 Controls

Section C503.5 of the IECC 2021 Commercial Provisions shall be replaced in its entirety as follows:

**C503.5 Lighting systems.** Lighting systems that are part of the *alteration* shall comply with Sections C503.5.1 and C503.5.2.

**C503.5.1 Interior Lighting and Controls.** Interior lighting and controls in *alterations* shall comply with the following:

1. Where the size or configuration of interior spaces is altered, those spaces shall be included in the lighting power compliance calculations required by C405.3 and lighting *controls* in those spaces shall comply with C405.2 and C408.
2. Where lighting *controls* are added or altered within a space, the lighting *controls* within that space shall comply with C405.2 and C408.
3. Where the connected interior lighting power within a space is altered, that space shall be included in the lighting power compliance calculations required by C405.3 and the existing lighting controls for that space shall undergo functional testing as follows:
   1. Verify that manual *controls* function.
   2. Verify that occupant sensors automatically turn off the lights when spaces are unoccupied.
   3. Verify that timeswitch controls are functioning, set to the correct day and time, programmed with scheduled off times, and provided with fresh backup batteries (where applicable).

**Exception:** Any space where the connected lighting power is reduced by at least 20 percent is not required to be included in the lighting power calculations required by C405.3.

**C503.5.2 Exterior Lighting and Controls.** Where exterior lighting controls are added or altered, those portions of the lighting control system which are added or altered shall comply with C405.2 and C408.

## Addition of New Section C503.6 Additional energy efficiency credits

Section C503 of the IECC 2021 Commercial Provisions shall be amended by the addition of a new section C503.6 as follows:

*Substantial energy alterations* shall comply with measures from sections C406.2 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Credits shall be achieved from Tables C406.1.3(1) through C406.1.3(9) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

**Exceptions:**

1. *Alterations* that are part of an *addition* complying with section C502.
2. *Alterations* that comply with Section C401.2.2.

PART 2

# Amendments to ASHRAE 90.1-2019

## Amendments to Section 3.2 Definitions

Amend Section 3.2 of ASHRAE 90.1-2019 by the amendment and addition of definitions of terms as follows:

***alteration:*** ~~a~~ replacing~~ement~~ or adding~~tion~~ to ~~a building or its~~ *systems, equipment,* or *building* assemblies; routine maintenance, *repair* and service, a change in the *building’s* use classification or *space conditioning category* ~~category~~ shall not constitute an *alteration*.

***automobile parking space:***  a space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

***commercial cooking appliances:*** appliances used in a commercial food service establishment for heating or cooking food. For the purpose of the definition, a commercial food service establishment is where food is prepared for sale or is prepared on a scale that is by volume and frequency not representative of domestic household cooking.

***common area:*** all portions of Group R occupancies that are not dwelling units or sleeping units.

***community renewable energy facility:*** a facility that produces energy harvested from *renewable energy* resources and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

***baseline building performance:*** the annual site *energy* ~~cost~~ for a *building* design intended for use as a baseline for rating above-standard design or when using the *Performance Rating Method* as an alternative path for minimum standard compliance in accordance with Section 4.2.1.1.

***ceiling fan energy index (CFEI):*** the ratio of the electric input power of a reference *ceiling fan* to the electric input power of the actual *ceiling fan* as calculated per AMCA 208 with the following modifications to the calculations for the reference fan: using an airflow constant (Q0) of 26,500. cfm (12.507 m3/s), a pressure constant (P0) of 0.002700 in. of water (0.6719 Pa), and a fan *efficiency* constant (η0) of 42%.

***dehumidifier:*** a self-contained, electrically operated, and mechanically encased product with the sole purpose of dehumidifying the space consisting of:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere,
2. A refrigerating system, including an electric motor,
3. An air-circulating fan, and
4. A means for collecting or disposing of the condensate.

A *dehumidifier* does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner.

***desiccant dehumidification system:*** a mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.

***east-oriented:*** facing within 45 degrees of true east to the south and within less than 22.5 degrees of true east to the north in the northern hemisphere; facing within 45 degrees of true east to the north and within less than 22.5 degrees of true east to the south in the southern hemisphere.

***electric vehicle (EV):*** an automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, *EVSE*, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

***electric vehicle supply equipment (EVSE):*** equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the electric vehicle connectors, attached plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

***electric vehicle supply equipment installed space (EVSE space):*** an *automobile parking space* that is provided with a dedicated *EVSE* connection.

***electric vehicle capable space*** ***(EV CAPABLE SPACE):*** a designated *automobile parking space* that is provided with electrical infrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an *EVSE*.

***electric vehicle ready space (EV READY SPACE):*** an *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE*.

***financial renewable energy power purchase agreement:*** a financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

***greenhouse:*** a structure or a thermally isolated area of a building that maintains a specialized sunlit environment with a skylight roof ratio of 50% or more above the growing area exclusively used for, and essential to, the cultivation, protection or maintenance of plants. Greenhouses are those that are erected for a period of 180 days or more.

***horticultural lighting:*** electric lighting used for horticultural production, cultivation or maintenance.

***indoor grow:*** a space, other than a *greenhouse*, used exclusively for, and essential to horticultural production, cultivation or maintenance.

***integrated HVAC system:*** an HVAC system designed to handle both sensible and latent heat removal. *Integrated HVAC systems* include, but are not limited to HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and dehumidifiers modified to allow external heat rejection.

***physical* *renewable evergy power purchase agreement:*** a contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

***renewable energy certificate (REC):*** a market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*, also known as "energy attribute" and "energy attribute certificate" (EAC).

***lighting power allowance (LPA), exterior:*** the maximum lighting power in watts allowed for the exterior of a *building*.

***lighting power allowance (LPA), interior:*** the maximum lighting power in watts allowed for the interior of a *building*.

***north-oriented:*** facing within ~~45~~67.5 degrees of true north in the northern hemisphere; ~~(however,~~ facing within 67.5 degrees of true south in the southern hemisphere.~~)~~

***on-site renewable energy:*** *energ*y ~~generated~~ from *renewable energy resources* ~~produced~~ harvested at the *building* site***.***

***overall U-factor:*** U-factor of above grade walls that includes clear field, linear, and point thermal bridges.

***parking garage section:*** a part of a parking garage where airflow is restricted from other parts of the garage by solid walls.

***Photosynthetic photon efficacy (PPE):*** photosynthetic photon flux emitted by a light source divided by its electrical input power in units of micromoles per second per watt, or micromoles per joule (μmol/J) between 400-700nm as defined by ANSI/ASABE S640.

***proposed building performance:*** the annual site *energy* ~~cost~~ calculated for a *proposed design*.

***renewable energy resources***: *energy* from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth.

***Residential associated HVAC zone:*** any HVAC zone that primarily includes nonresidential spaces designed to serve occupants of residential spaces, including but not limited to corridors, stairwells, elevator lobbies, and common restrooms, on a floor where over 75% of the gross conditioned floor area are residential spaces. This definition does not apply to HVAC zones within hospitals.

***service hot water.*** heating water for domestic or commercial purposes other than space heating and process application requirements.

***site energy*:** the energy content of all fuels consumed at the *building* site to operate a *building*

***~~site-solar energy:~~*** ~~thermal, chemical, or electrical~~ *~~energy~~* ~~derived from direct conversion of incident solar radiation at the~~ *~~building~~* ~~site and used to offset consumption of purchased~~ *~~fuel~~* ~~or electrical~~ *~~energy~~* ~~supplies. For the purposes of applying this standard,~~ *~~site-solar energy~~* ~~shall not include passive heat gain through~~ *~~fenestration~~**~~systems~~*.

***south-oriented:*** facing within 45 degrees of true south in the northern hemisphere; facing within 45 degrees of true north in the southern hemisphere.

***thermal bridge:*** an element or interface of elements that has higher thermal conductivity than the surrounding building thermal envelope, which creates a path of least resistance for heat transfer.

***PSI-FACTOR (ψ- factor).*** *The heat loss factor per unit length of a thermal bridge characterized as a linear element of a building thermal envelope (Btu/h x ft x F) [W/(m x K)].*

***CHI-FACTOR (χ- factor).*** *The heat loss factor for a single thermal bridge characterized as a point element of a building thermal envelope (Btu/h x F) [W/K].*

***Clear field thermal bridge.*** *An area-based thermal transmittance associated with elements of a building envelope assembly which repeats at regular intervals. Examples of clear field thermal bridges include metal or wood studs, brick ties, and cladding attachments such as z-girts.*

***Clear field U- factor.*** *Thermal performance factor that accounts for clear field thermal bridge.*

***Overall U-factor.*** *U-factor of above grade walls that includes clear field, linear, and point thermal bridges.*

***trim compressor:*** a compressor that is designated for part-load operation, handling the short-term variable trim load of end uses, in addition to the fully loaded base compressors.

***west-oriented:*** facing within 45 degrees of true west to the south and within less than 22.5 degrees of true west to the north in the northern hemisphere; facing within 45 degrees of true west to the north and within less than 22.5 degrees of true west to the south in the southern hemisphere.

***total system performance ratio (TSPR):*** The ratio of the sum of a *building’s* annual heating and cooling load in thousand Btu to the sum of annual site *energy* input of the *building* mechanical *systems*.

***TSPR reference building design:*** a computer representation of a hypothetical *building* design based on modifications to the *proposed design* in accordance with Section J.4.3. This representation is used as the basis for calculating the mechanical *total system performance ratio* for determining alternative mechanical *system* performance in accordance with Section 6.2.2 (c) and Normative Appendix J.

## Addition to Section 3.3 Abbreviations and Acronyms

Section 3.3 of ASHRAE 90.1-2019 shall be amended by the addition of abbreviations and acronyms as follows:

*CFEI*  ceiling fan energy index

*~~E~~~~t~~* Et thermal *efficiency*

*LPA*  the maximum lighting power allowed in watts

DOAS dedicated *outdoor air* *system*

FPTU fan powered terminal unit

HWST heating water loop supply temperature

MPF Mechanical Performance Factor

OAT *outdoor air* temperature, db unless wb specified

OSA *outdoor air*

RAT return air temperature, db unless wb specified

VSD variable speed drive

SAT supply air temperature, db unless wb specified

SHW service hot water

*TSPR total system performance ratio*

*TSPR*p *TSPR* of a *proposed design*

*TSPR*r *TSPR* of a *reference building design*

## Amendments to Section 4.2.1.1 New Buildings

Section 4.2.1.1 of ASHRAE 90.1-2019 shall be amended to read as follows:

**4.2.1.1 New Buildings**

New *buildings* shall comply with Sections [4.2.2](bookmark://_bookmark18) through [4.2.](bookmark://_bookmark24)5 and either the provisions  of Section [5](bookmark://_bookmark37), “*Building Envelope*”; Section [6](bookmark://_bookmark96), “Heating, Ventilating, and Air Conditioning”; Section [7](bookmark://_bookmark217), “*Service Water Heating*”; Section [8](bookmark://_bookmark240), “Power”; Section [9](bookmark://_bookmark259), “Lighting”; ~~and~~ Section [10](bookmark://_bookmark313), “Other *Equipment*” and Section 11, “Additional Efficiency Requirements,” or ~~Section~~ [~~11~~](bookmark://_bookmark337)~~, “~~*~~Energy Cost Budget~~* ~~Method,” or~~ [Normative Appendix G](bookmark://_bookmark444), “*Performance Rating Method*.” When using [Normative Appendix G](bookmark://_bookmark444) the Performance Site Energy ~~Cost~~ Index (PSEI) of new *buildings*, *additions* to *existing buildings*, and/or *alterations* to *existing buildings* shall be less than or equal to the Performance Site Energy ~~Cost~~ Index Target (PSE~~C~~I *t*) when calculated in accordance with the following:

PSE~~C~~I t= ECA x [BBUSE~~EC~~ + (BPF × BBRSE~~EC~~) - PRE] / BBP

Where

PSE~~C~~I = Performance *Site Energy* ~~Cost~~ Index calculated in accordance with Section [G1.2](bookmark://_bookmark446).

BBUSE~~EC~~ = baseline *building* unregulated *site* *energy* ~~cost~~, the portion of the annual *energy* cost of a *baseline building design* that is due to *unregulated energy use.*

BBRSE~~EC~~ = baseline *building* regulated *site* *energy* ~~cost~~, the portion of the annual *site* *energy* ~~cost~~ of a *baseline building design* that is due to *regulated energy use.*

BPF = *building* performance factor from Table [4.2.1.1](bookmark://_bookmark16). For *building* area types not listed in Table [4.2.1.1](bookmark://_bookmark16) use “All others.” Where a *building* has multiple *building* area types, the required BPF shall be equal to the area-weighted average of the *building* area types based on their *gross floor area*.

Where a project includes an *existing building* and an *addition*, the BPF shall be equal to the area-weighted average of the *existing building*BPF determined following Section 4.2.1.3 and the *addition* BPF from Table [4.2.1.1](http://4.2.1.1/) based on the *gross floor area*.

BBP = baseline building performance.

PBP = *proposed building performance*, including the reduced, annual purchased *site* *energy* ~~cost~~ associated with all *on-site renewable energy* generation systems.

ECA = energy credit adjustment, calculated as follows:

ECr = Required energy credits in accordance with Section C406.1.1

ECx = Energy credits for measures included in the building and excluded from modeling by Table 4.2.1.2.

Where a *building* includes either an addition, core-and-shell and initial build-out or alterations, ECx and ECr shall be equal to the area-weighted average of the requirements applicable to each based on their *gross floor area*

Where a *building* includes multiple *building* area types, the ECx and ECr shall be equal to the area weighted average of the *building* area types based on their *gross floor area*.

PBP*nre* *=* *proposed building performance* without any credit for reduced annual *site* *energy* ~~cost~~ from on-site renewable energy generation systems.

PBP*pre* *=* *proposed building performance,* excluding any renewable energy system in theproposed designand including an *on-site renewable energy* system that meets but not exceeds the requirements of Section 10.5.1.1 excluding exceptions modeled following the requirements for a *budget building design* in Section G2.4.1.3.

PRE = PBP*nre* - PBP*pre*

When (PBP*pre* – PBP)/BBP > 0.05, new *buildings*, *additions* to *existing buildings*, and/or *alterations* to *existing buildings* shall comply with the following:

PSEI + [(PBP*pre* – PBP)/BBP] – 0.05 < PSEI*t*

Informative Notes:

1. PBPnre = proposed building performance, excluding both the renewable energy and actual performance of the systems providing purchased hot water, steam or chilled water
2. PBPpre = proposed building performance, prescriptive renewable energy
3. PRE = prescriptive renewable energy

~~When (PBP~~*~~nre~~* ~~– PBP)/BBP > 0.05, new~~ *~~buildings~~*~~,~~ *~~additions~~* ~~to~~ *~~existing buildings~~*~~, and/or~~ *~~alterations~~* ~~to~~ *~~existing buildings~~* ~~shall comply with the following:~~

~~PSECI + [(PBP~~*~~nre~~* ~~– PBP)/BBP] – 0.05 < PCI~~*~~t~~*

~~Regulated~~ *~~energy~~* ~~cost shall be calculated by multiplying the total~~ *~~energy~~* ~~cost by the ratio of~~ *~~regulated energy use~~* ~~to total~~ *~~energy~~* ~~use for each~~ *~~fuel~~* ~~type. Unregulated~~ *~~energy~~* ~~cost shall be calculated by subtracting regulated~~ *~~energy~~* ~~cost from total~~ *~~energy~~* ~~cost.~~

**Table 4.2.1.1 Building Performance Factor (BPF)**

|  |  |  |  |
| --- | --- | --- | --- |
| ***Building***  **Area Type** | **Climate Zone** | | |
| **4A** | **5A** | **6A** |
| Multifamily | TBD | TBD | TBD |
| Healthcare/ hospital | TBD | TBD | TBD |
| Hotel/motel | TBD | TBD | TBD |
| Office | TBD | TBD | TBD |
| Restaurant | TBD | TBD | TBD |
| Retail | TBD | TBD | TBD |
| School | TBD | TBD | TBD |
| Warehouse | TBD | TBD | TBD |
| All others | TBD | TBD | TBD |

***Note to reviewers****: BPFs will be determined using energy modeling that will include the following key changes compared to 90.1 2019:*

*1. Baseline design prototypes to be updates to reflect configuration of Appendix G baseline, to align with the methodology used for 90.1 2022 BPFs.*

*2. Proposed design prototypes updated to reflect stringency of NYStretch 2023 prescriptive path*

*3. Calculated using baseline and proposed energy use expressed in units of site energy instead of energy cost.*

**Table 4.2.1.2 Energy Efficiency Credits Excluded from Modeling**

|  |  |  |  |
| --- | --- | --- | --- |
| **Energy Credit ID** | **Energy Credit Abbreviated Title** | **Section** |  |
|  |
| W04 | SHW pipe insulation | C406.2.3.2 |  |
| W05 | Point-of-use *water heaters* | C406.2.3.3 a |  |
| W06 | Thermostatic balancing valves | C406.2.3.3 b |  |
| W07 | SHW heat trace system | C406.2.3.3 (3) |  |
| W08 | SHW submeters | C406.2.3.4 |  |
| P01 | *Energy* monitoring | C406.2.4 |  |
| Q02 | Efficient Kitchen *Equipment* | C406.2.7.2 |  |
| Q04 | Fault detection | C406.2.7.3 |  |

***Note to reviewers:*** *sections will be renumbered when C406 is included into Section 11.*

## Amendments to Section 4.2.1.2 Additions to Existing Buildings

Amend Section 4.2.1.2 of ASHRAE 90.1-2019 as follows:

**4.2.1.2 Additions to Existing Buildings**

*Additions* to *existing buildings* shall comply with the provisions of Sections [4.2.2](bookmark://_bookmark18) through [4.2.5](bookmark://_bookmark24) and one of the following:

1. Section [5](bookmark://_bookmark37), “*Building Envelope*”; Section [6](bookmark://_bookmark96), “Heating, Ventilating, and Air Conditioning”; Section [7](bookmark://_bookmark217), “*Service Water Heating*”; Section [8](bookmark://_bookmark240), “Power”; Section [9](bookmark://_bookmark259), “Lighting”; ~~and~~ Section [10](bookmark://_bookmark313), “Other *Equipment*,” and Section 11, “Additional Efficiency Requirements,” or

~~2. Section~~ [~~11~~](bookmark://_bookmark337)~~, “Energy Cost Budget Method,” or~~

2. [Normative Appendix G](bookmark://_bookmark444), “Performance Rating Method” in accordance with Section

[**4.2.1.1**](bookmark://_bookmark15)

When an *addition* to an *existing building* cannot comply by itself, trade-offs will be allowed by modification to one or more of the existing components of the *existing building*. Modeling of the modified components of the *existing building* and *addition* shall employ the procedures of ~~Section~~ [~~11~~](bookmark://_bookmark337) ~~or~~ [Normative Appendix G](bookmark://_bookmark444); the *addition* shall not increase the *energy* consumption of the *existing building* plus the *addition* beyond the *energy* that would be consumed by the *existing building* plus the *addition* if the *addition* alone did comply.

## Amendments to Section 4.2.1.3 Alterations to Existing Buildings

Amend Section 4.2.1.3 of ASHRAE 90.1-2019 as follows:

**4.2.1.3 Alterations of Existing Buildings Assemblies, Systems, and Equipment**

*Alterations* of *existing buildings* assemblies, systems, and equipment shall comply with the provisions of Sections [4.2.2](bookmark://_bookmark18) through [4.2.5](bookmark://_bookmark24) and one of the following:

1. Section [5](bookmark://_bookmark37), “*Building Envelope*”; Section [6](bookmark://_bookmark96), “Heating, Ventilating, and Air Condition- ing”; Section [7](bookmark://_bookmark217), “*Service Water Heating*”; Section [8](bookmark://_bookmark240), “Power”; Section [9](bookmark://_bookmark259), “Lighting”; Section [10](bookmark://_bookmark313), “Other *Equipment*,” and Section 11, “Additional Efficiency Requirements,” or

~~Section~~ [~~11~~](bookmark://_bookmark337)~~, “Energy Cost Budget Method,” or~~

1. [Normative Appendix G](bookmark://_bookmark444), “Performance Rating Method.” in accordance with Section [4.2.1.1](bookmark://_bookmark15) with the following modifications:
   * + 1. *Alterations* that meet the criteria in G3.1.3(a) shall use the BPF from Table 4.2.1.1 multiplied by 1.05.
       2. All other *alterations* modeled following Section G3.3 shall use BPF=1.

**Exception to 4.2.1.3**

A *building* that has been specifically designated as historically significant by the *adopting authority* or is listed in The National Register of *Historic* Places or has been determined to be eligible for listing by the U.S. Secretary of the Interior need not comply with these requirements.

## Amendments to Section 4.2.4 Inspections

Amend Section 4.2.4 of ASHRAE 90.1-2019 as follows:

**4.2.4 Inspections**

All *building construction*, additions or *alterations* work subject to the provisions of this standard shall remain accessible and exposed for inspection purposes until approved in accordance with the procedures specified by the *building official*. The *building official,* upon notification, shall make the inspections set forth in Section4.2.4.1 through 4.2.4.6.

**4.2.4.1 Fenestration Inspections**

*Fenestration* shall be inspected in accordance with the compliance path selected in Section 4.2.1 and approved documentation provided in Section 4.2.2.

**4.2.4.2 Opaque Assembly Thermal Insulation Inspections**

*Opaque* Assemblies shall be inspected in accordance with the compliance path selected in Section 4.2.1 and approved documentation provided in Section 4.2.2.

**4.2.4.3 Continuous Air Barrier Inspections**

Where a *continuous air barrier* is installed as a component of an *opaque roof*, *above-grade walls* and *below-grade walls*, or *floors*, it shall be inspected for compliance in accordance with Section 5.8.3.1. Integration with adjoining *fenestration* and other *continuous air barrier* elements shall be in accordance with Section 5.4.3.1.

**4.2.4.4 Operable Fenestration and Door Inspections**

*Fenestration* and *door* closers inclusive of operating mechanisms shall be installed in accordance with *manufacturer’s* installation instructions. Associated seals and gaskets shall be installed accordance with *manufacturer’s* installation instructions and consistent with the provisions of Section 5.4.3.

**4.2.4.5 Loading Dock Weatherseals Inspections**

Loading dock, weatherseals shall be inspected for installation and to verify that the seals are in good condition.

**4.2.4.6** **Other Inspections**

Other inspections related to mechanical, plumbing, lighting and other equipment or shall be inspected in accordance with the compliance path selected in Section 4.2.1 and approved documentation provided in Section 4.2.2 or as otherwise required by the *building official*.

## Amendments to Restructure and Amend Section 5.1 New Buildings

Amend Sections 5.1.2 through 5.1.5 of ASHRAE 90.1-2019 as follows:

**5.1** **General**

**5.1.1** **Scope**

Section 5 specifies requirements for the *building envelope*.

**5.1.2** **New Buildings**

*Building envelope* components installed in new *buildings* shall comply with the requirements of section 5.2.

**5.1.3** **Additions to existing buildings**

*Building envelope* components installed in *additions* shall comply with the requirements of section 5.2.

*… renumber section 5.1.2 to 5.1.6*

**~~5.1.2~~ 5.1.6** **Space Conditioning Categories**

**~~5.1.2.1~~ 5.1.6.1**

Separate *building envelope* requirements are specified for (a) *nonresidential conditioned* space, (b) residential conditioned space, and (c) semiheated space.

**~~5.1.2.2~~ 5.1.6.2**

The minimum *skylight* area requirements in Section 5.5.4.2.3 are also specified for *unconditioned spaces*.

**~~5.1.2.3~~ 5.1.6.3**

*Spaces* shall be assumed to be *conditioned spaces* and shall comply with the requirements for *conditioned spaces* at the time of *construction*, regardless of whether mechanical or electrical *equipment* is included in the *building* permit application or installed at that time.

**Exception to ~~5.1.2.3~~ 5.1.6.3**

A *space* may be designated as either a *semiheated space* or an *unconditioned space* only if approved by the *building official*.

*… renumber section 5.1.3 to 5.1.4*

**~~5.1.3~~ 5.1.4** **Envelope Alterations to building envelopes**

*Alterations* to the *building envelope* shall comply with the requirements of Section 5.2 for insulation, air leakage, and *fenestration* applicable to those specific portions of the *building* that are being altered.

**Exceptions to ~~5.1.3~~ 5.1.4**

The following *alterations* need not comply with these requirements, provided such *alterations* will not increase the *energy* use of the *building*:

1. ...

*… renumber section 5.1.4 to 5.1.5*

**~~5.1.4~~ 5.1.5** **Climate**

Determine the climate zone for the location. For U.S. locations, follow the procedure in Section ~~5.1.4.1~~ 5.1.5.1. For international locations, follow the procedure in Section ~~5.1.4.2~~ 5.1.5.2.

**~~5.1.4.1~~ 5.1.5.1** **United States Locations**

For locations in the United States and its territories, use ASHRAE Standard 169, Table B-1, “U.S. Climate Zones by State and County,” to determine the assigned climate zone and, where required, the assigned climate zone letter.

**~~Exception to 5.1.4.1 5.1.5.1~~**

~~If there are recorded historical climatic data available for a~~ *~~construction~~* ~~site, they may be used to determine compliance if approved by the~~ *~~building official~~*~~.~~

***~~Informative Note~~***

~~Annex 1 (included at the end of this document) contains an extraction from ASHRAE Standard 169, Table B-1, “U.S. Climate Zones by State and County.”~~

**~~5.1.4.2 5.1.5.2~~****~~International Locations~~**

~~For locations in Canada that are listed in ASHRAE Standard 169, Table A-5, “Canada Stations and Climate Zones,” use this table to determine the required assigned climate zone number and, where required, the assigned climate zone letter. For locations in other international countries that are listed in ASHRAE Standard 169, Table A-6, “International Stations and Climate Zones,” use this table to determine the required climate zone number and, where required, the assigned climate zone letter. For all international locations that are not listed either in ASHRAE Standard 169, Table A-5, “Canada Stations and Climate Zones,” or ASHRAE Standard 169, Table A-6, “International Stations and Climate Zones,” use ASHRAE Standard 169, Section A3, “Climate Zone Definitions,” and Table A-3, “Thermal Climate Zone Definitions,” to determine both the climate zone number and letter.~~

***~~Informative Note~~***

~~Annex 1 (included at the end of this document) contains extractions from ASHRAE Standard 169, Table A-5, “Canada Stations and Climate Zones”; ASHRAE Standard 169, Table A-6, “International Stations and Climate Zones”; ASHRAE Standard 169, Section A3, “Climate Zone Definitions”; and Table A-3, “Thermal Climate Zone Definitions.”~~

## Add New Section 5.4.1.1 Thermal Bridging Documentation and Calculation*.*

Section 5.4.1.1 shall be added to ASHRAE 90.1-2019 to read as follows:

**5.4.1.1 Thermal Bridging Documentation and Calculation (Mandatory)**

Construction documents shall provide details of assembly intersections described in Section 5.4.1.1.1 below, including:

1. *Clear field thermal bridges*, determined using ASHRAE 90.1 2019 Appendix A.
2. *Linear thermal bridges*, including total length of each type in Table 5.4, corresponding Psi-factors, and their source.
3. *Point thermal bridges*, including their cross-sectional area and quantity of each type, corresponding Chi-factors, and their source.

**Exception to 5.4.1.1(3)**

*Point thermal bridges* related to HVAC or electrical systems totaling less than 12 square inches of cross-sectional area at exposure.

1. The *overall assembly U-factor* calculated in accordance with Section 5.4.1.1.2 and including the U-factors for all intersections described in Section 5.4.1.1.1.

**5.4.1.1.1 Accounting for Thermal Bridging (Mandatory)**

The calculated *overall U-factor* shall include the following intersections where they occur in the building:

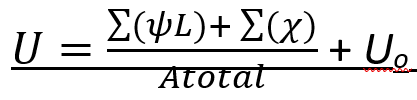
1. Structural framing and members.
2. Cladding attachment systems.

3. Assembly intersections:

1. Roof edge
2. Parapet
3. Intermediate floor balcony or overhang to opaque wall intersection
4. Intermediate floor balcony in contact with vertical fenestration
5. Cladding support
6. Wall to vertical fenestration intersection

**5.4.1.1.2 Overall U-factor calculation (Mandatory) of above-grade wall assembly**

~~The wall assembly U-factor including the clear-field assembly transmittance and the transmittances from~~ *~~thermal bridging~~* ~~shall be calculated in accordance with Equation 5.4.1.1.2.~~

~~ (Equation 5.4.1.1.2)~~

~~Where:~~

~~U =~~ *~~Overall U-factor~~*

~~Uo = Clear field U-factor~~

~~ = Psi-factor of the assembly detail~~

~~L = Length of the linear thermal bridging object~~

~~ = Chi-factor of the assembly detail~~

~~A~~~~total~~ ~~= Total assembly area~~

Where a thermal bridge is not accounted for as a separate element, the clear-field U-factors of above-grade wall assemblies shall bemodified in accordance with Equation C402.6.2.

Utot = ( [ ( ∑ ψi ∙ Li ) + ( ∑ χj ∙ nj ) ] /Atotal )+Uo (Equation 5.4.1.1.2)

Where:

Utot = overall thermal transmittance including the effect of *linear thermal bridges* and *point thermal bridges* not included in the assembly’s Uo value, Btu/(h∙ft2∙oF) or W/(m2∙K)

Uo = clear field thermal transmittance of the assembly as determined in accordance with Section 5, Btu/(h∙ft2∙oF) or W/(m2∙K)

Atotal = total *opaque* projected surface area of the assembly, in ft2 (m2)

ψi = *Psi-factor*, thermal transmittance for each type of *linear thermal bridge*, Btu/(h·ft·°F) (W/(m·K))

Li = length of a particular *linear thermal bridge* as measured on the outside surface of the *building envelope*, ft (m)

χi = *Chi-factor*, thermal transmittance for each detail type of *point thermal bridge*, Btu/(h·°F) (W/K)

ni = the number of occurrences a particular type of *point thermal bridge*

**5.4.1.1.3 Determination of Psi-factors and Chi-factors (Mandatory)**

Psi- and chi- factors shall be calculated or derived using:

1. Simulation models compliant in accordance with ISO 10211, Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations.
2. Assembly testing in accordance with ASTM C1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
3. ~~From~~ ISO 14683, Thermal bridges in building construction — Linear thermal transmittance — Simplified methods and default values.
4. ~~Industry tools that meet one or more of the Standards listed in this section.~~
5. ~~Selection of a corresponding detail from the~~ BC Hydro’s Building Envelope Thermal Bridging Guide.
6. ~~Unmitigated above-grade wall psi- and chi-factors provided in~~ Table 5.4, for above-grade wall psi factors that are provided for use when thermal bridging mitigation is not specified and not implemented.

**Table 5.4 Default Factors for Unmitigated Thermal Bridging Details**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Assembly Type | Thermal Bridge Factors | Roof Edge | Parapet | Intermediate floor to wall intersection | Intermediate floor balcony or overhang to opaque wall intersection | Intermediate floor balcony in contact with Vertical Fenestration | Cladding Support | Wall to Vertical Fenestration intersection |
| Metal-framed and Metal Buildings | Psi-Factor | 0.45 | 0.289 | 0.487 | 0.487 | 0.974 | 0.314 | 0.262 |
| Mass (exterior or integral) | Psi-Factor | 0.5 | 0.238 | 0.476 | 0.476 | 0.974 | 0.27 | 0.188 |
| Mass (interior) | Psi-Factor | 0.5 | 0.511 | 0.476 | 0.476 | 0.974 | n/a | 0.313 |
| Wood-framed and Other | Psi-Factor | 0.45 | 0.032 | 0.336 | n/a | n/a | 0.186 | 0.15 |

**Informative Note:** The Building Envelope Thermal Bridging Guide is available in an easy to navigate format at <https://thermalenvelope.ca/>.

## Add New Section 5.4.1.2 Thermal Resistance of Mechanical Equipment Penetrations

Section 5.4.1.2 shall be added to ASHRAE 90.1-2019 to read as follows:

**5.4.1.2 Thermal resistance of mechanical equipment penetrations.** When the total area of penetrations from through-the-wall mechanical equipment exceeds 1 percent of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5.

**Exception:** Where mechanical equipment has been tested in accordance with testing standards approved by the authority having jurisdiction, the mechanical equipment penetration area may be calculated as a separate wall assembly with the U-factor as determined by such test.

## Amendments to Whole-Building Air Leakage

Amend Section 5.4.3.1.1 of ASHRAE 90.1-2019 as follows:

**5.4.3.1.1 Whole-Building Air Leakage**  
Whole-building pressurization testing shall be conducted in accordance with ASTM E779, ASTM E3158, or ASTM E1827 by an independent third party. The measured air leakage rate of the *building envelope* shall not exceed ~~0.40~~ 0.15 cfm/ft2 under a pressure differential of 0.3 in. of water, with this air leakage rate normalized by the sum of the above-grade and below-grade *building envelope* areas of the *conditioned space* and *semiheated space.*

**[…]**

**Exceptions to 5.4.3.1.1**

[…]

For *existing buildings* ~~W~~where the measured air leakage rate exceeds ~~0.40~~ 0.15 cfm/ft2 but does not exceed ~~0.60~~ ~~0.20~~ 0.40 cfm/ft2, a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the *building* is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. In addition, a visual inspection of the air barrier shall be conducted, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the *code official* and the *building* owner and shall be deemed to satisfy the requirements of this section.

*~~Continuous air barrier~~* ~~design and installation verification program in accordance with Section.~~

## Amendments to Prescriptive Envelope Requirements

Amend Section 5.5 Prescriptive Building Envelope Compliance Path and Replace Table 5.5 in ASHRAE 90.1-2019 as follows:

* + 1. **Exterior Building Envelope**

For a *conditioned space*, the *exterior building envelope* shall comply with either the *nonresidential* or *residential* requirements in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5 for the appropriate climate.

The exterior surfaces of conditioned vestibules shall comply with the *building envelope* requirements for a *conditioned space*.

* + 1. **Semiexterior Building Envelope**

If a *building* contains any *semiheated space* or *unconditioned space* then the *semiexterior building envelope* shall comply with the requirements for *semiheated space* in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5 for the appropriate climate. (See Figure [5.5.2](#_bookmark58).)

The interior surfaces and exterior surfaces of unconditioned

**5.5.3 Opaque Areas**

For all *opaque* surfaces except *doors*, compliance shall be demonstrated by ~~one of~~ the following ~~two methods~~:

* + - 1. ~~Minimum rated~~ *~~R-value~~* ~~of insulation for the~~ *~~thermal resistance~~* ~~of the added insula- tion in framing cavities and~~ *~~continuous insulation~~* ~~only. Specifications listed in~~ [Normative Appendix A](https://gbc-word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en%2DUS&rs=en%2DUS&wopisrc=https%3A%2F%2Fnysemail.sharepoint.com%2Fsites%2Fnyserda-ext%2FExternalCollaboration%2FContractors%2FNYSERDAECP%2F_vti_bin%2Fwopi.ashx%2Ffiles%2Faf8abe4f84014492bbbf545c84210f32&wdenableroaming=1&mscc=0&hid=A81D3CA0-30FA-1000-DDE4-4B4E8986880B&wdorigin=ItemsView&wdhostclicktime=1652214838764&jsapi=1&jsapiver=v1&newsession=1&corrid=7a16d1b7-7cb2-4b6f-ba64-4150bf278327&usid=7a16d1b7-7cb2-4b6f-ba64-4150bf278327&sftc=1&cac=1&mtf=1&sfp=1&instantedit=1&wopicomplete=1&wdredirectionreason=Unified_SingleFlush&rct=Medium&ctp=LeastProtected#_bookmark358) ~~for each~~ *~~class of construction~~* ~~shall be used to determine compliance.~~

Maximum *U-factor*, *C-factor*, or *F-factor* for the entire assembly. The values for typical *construction* assemblies listed in [Normative Appendix A](https://gbc-word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en%2DUS&rs=en%2DUS&wopisrc=https%3A%2F%2Fnysemail.sharepoint.com%2Fsites%2Fnyserda-ext%2FExternalCollaboration%2FContractors%2FNYSERDAECP%2F_vti_bin%2Fwopi.ashx%2Ffiles%2Faf8abe4f84014492bbbf545c84210f32&wdenableroaming=1&mscc=0&hid=A81D3CA0-30FA-1000-DDE4-4B4E8986880B&wdorigin=ItemsView&wdhostclicktime=1652214838764&jsapi=1&jsapiver=v1&newsession=1&corrid=7a16d1b7-7cb2-4b6f-ba64-4150bf278327&usid=7a16d1b7-7cb2-4b6f-ba64-4150bf278327&sftc=1&cac=1&mtf=1&sfp=1&instantedit=1&wopicomplete=1&wdredirectionreason=Unified_SingleFlush&rct=Medium&ctp=LeastProtected#_bookmark358) shall be used to determine compliance. Thermal bridging calculation and documentation shall comply with Section 5.4.1.1.

**Table 5.5~~\*~~****Building Envelope Requirements for Climate Zones 4, 5, and 6**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Climate Zone** | **4** | | **5** | | **6** | | **4, 5, 6** |
| **All other** | **Group R** | **All other** | **Group R** | **All other** | **Group R** | **Semiheated** |
| **Roofs** | | | | | | |  |  |  |  |  |  |  |
| Insulation Entirely above deck | 0.016 | 0.016 | 0.016 | 0.016 | 0.014 | 0.014 | 0.063 |
| Metal building | 0.016 | 0.016 | 0.016 | 0.016 | 0.014 | 0.014 | 0.060 |
| Attic and other | 0.013 | 0.013 | 0.013 | 0.013 | 0.012 | 0.012 | 0.034 |
| **Walls, above grade~~\*~~a** | | | | | | |  |  |  |  |  |  |  |
| Mass | 0.056 | 0.053 | 0.053 | 0.050 | 0.050 | 0.047 | 0.151 |
| Metal building | 0.058 | 0.057 | 0.055 | 0.054 | 0.052 | 0.051 | 0.094 |
| Steel-framed | 0.058 | 0.057 | 0.055 | 0.054 | 0.052 | 0.051 | 0.084 |
| Wood framed and other | 0.039 | 0.040 | 0.036 | 0.037 | 0.033 | 0.034 | 0.089 |
| **Walls, below grade** | | | | | | |  |  |  |  |  |  |  |
| Below-grade wall | C-0.059 | C-0.060 | C-0.061 | C-0.062 | C-0.048 | C-0.048 | C-0.119 |
| **Floors** | | | | | | |  |  |  |  |  |  |  |
| Mass | 0.053 | 0.053 | 0.053 | 0.053 | 0.043 | 0.043 | 0.087 |
| Steel joist | 0.054 | 0.054 | 0.054 | 0.054 | 0.044 | 0.044 | 0.052 |
| Wood-framed and other | 0.054 | 0.054 | 0.054 | 0.054 | 0.044 | 0.044 | 0.051 |
| **Slab-on-grade floors** | | | | | | |  |  |  |  |  |  |  |
| Unheated slabs | F-0.52 | F-0.52 | F-0.52 | F-0.52 | F-0.51 | F-0.51 | NR |
| Heated slabs | F-0.62 | F-0.62 | F-0.62 | F-0.62 | F-0.62 | F-0.60 | F-0.86 |
| **Opaque doors** | | | | | | |  |  |  |  |  |  |  |
| Non-swinging | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| Swinging | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 | 0.37 |
| Garage door <14% glazing | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 | 0.31 |
| *Vertical Fenestration*, 0% to 40% of *Wall* |  |  |  |  |  |  |  |
| *U-factor* |  |  |  |  |  |  |  |
| Fixed | ~~0.26~~ 0.22 | ~~0.26~~ 0.22 | ~~0.25~~ 0.20 | ~~0.25~~ 0.20 | ~~0.20~~ 0.18 | ~~0.20~~ 0.18 | 0.39 |
| Operable | ~~0.32~~ 0.26 | ~~0.32~~ 0.26 | ~~0.31~~ 0.24 | ~~0.31~~ 0.24 | ~~0.25~~ 0.22 | ~~0.25~~ 0.22 | 0.48 |
| Entrance Door | ~~0.63~~ 0.55 | ~~0.63~~ 0.55 | ~~0.63~~ 0.55 | ~~0.63~~ 0.55 | ~~0.63~~ 0.55 | ~~0.63~~ 0.55 | 0.68 |
| SHGC | 0.25 | 0.25 | 0.32 | 0.32 | 0.36 | 0.36 | NR |
| VT/SHGC | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | NR |
| *Skylight*, 0% to 3% of *Roof* |  |  |  |  |  |  |  |
| *U-factor* | ~~0.48~~ 0.40 | ~~0.48~~ 0.40 | ~~0.48~~ 0.40 | ~~0.48~~ 0.40 | ~~0.48~~ 0.40 | ~~0.48~~ 0.40 | 0.75 |
| *SHGC* | ~~0.36~~ 0.30 | ~~0.36~~ 0.30 | ~~0.36~~ 0.30 | ~~0.36~~ 0.30 | ~~0.36~~ 0.30 | ~~0.36~~ 0.30 | NR |

~~\*~~a.Walls, above grade U-factors include thermal bridging impact calculated in accordance with 5.4.1.1.

## Amendments to 5.5.3.1 Roof Insulation

Amend Section 5.5.3.1 of ASHRAE 90.1-2019 as follows:

**5.5.3.1 Roof Insulation**

All *roofs* shall comply with the ~~insulation~~ values specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5. *Skylight* curbs shall be insulated to the level of *roofs* with insulation entirely above deck or R-5.0, whichever is less.

## Amendments to 5.5.3.2 Above-grade Wall Insulation

Amend Section 5.5.3.2 of ASHRAE 90.1-2019 as follows:

**5.5.3.2 Above-Grade Wall Insulation**

All *above-grade walls* shall comply with the ~~insulation~~ values specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

**~~Exception to 5.5.3.2~~**

~~Alternatively, for~~ *~~mass walls~~*~~, where the requirement in Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56) ~~is for a maxi- mum assembly U-0.151 followed by footnote “b,” ASTM C90 concrete block~~ *~~walls~~*~~, ungrouted or partially grouted at 32 in. or less on center vertically and 48 in.or less on center horizontally, shall have ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu·in./ h·ft2·°F. Other~~ *~~mass walls~~* ~~with integral insulation shall meet the criteria when their~~ *~~U-factors~~* ~~are equal to or less than those for the appropriate thickness and density in the “Partly Grouted, Cells Insulated” column of Table~~ [~~A3.1-3~~](#_bookmark377)~~.~~

## Amendments to 5.5.3.3 Below-grade Wall Insulation

Amend Section 5.5.3.3 of ASHRAE 90.1-2019 as follows:

**5.5.3.3 Below-Grade Wall Insulation**

*Below-grade walls* shall ~~have a~~ *~~rated R-value of insulation~~* ~~no less than~~ comply with the ~~insulation~~ values specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

**~~Exception to 5.5.3.3~~**

~~Where framing, including metal and wood studs, is used, compliance shall be based on the maxi- mum assembly~~ *~~C-factor~~*~~.~~

## Amendments to 5.5.3.4 Floor Insulation

Amend Section 5.5.3.4 of ASHRAE 90.1-2019 as follows:

**5.5.3.4 Floor Insulation**

All *floors* shall comply with the insulation values specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.3.5 Slab-on-Grade Floor Insulation

Amend Section 5.5.3.5 of ASHRAE 90.1-2019 as follows:

**5.5.3.5 Slab-on-Grade Floor Insulation**

All *slab-on-grade floors*, including *heated slab-on-grade floors* and *unheated slab-on-grade floors*, shall comply with the insulation values specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.3.6 Opaque Doors

Amend Section 5.5.3.6 of ASHRAE 90.1-2019 as follows:

**5.5.3.6 Opaque Doors**

All *opaque doors* shall have a *U-factor* not greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.4.2 Fenestration Area

Amend Section 5.5.4.2 of ASHRAE 90.1-2019 as follows:

**5.5.4.2 Fenestration Area**

**5.5.4.2.1 Vertical Fenestration Area**

The total *vertical fenestration area* shall not be greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

**5.5.4.2.2 Maximum Skylight Fenestration Area**

The total *skylight area* shall not be greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.4.3 Fenestration U-factor

Amend Section 5.5.4.3 of ASHRAE 90.1-2019 as follows:

**5.5.4.3 Fenestration U-factor**

*Fenestration* shall have a *U-factor* not greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.4.4 Fenestration Solar Heat Gain Coefficient (SHGC)

Amend Section 5.5.4.4 of ASHRAE 90.1-2019 as follows:

**5.5.4.4 Fenestration Solar Heat Gain Coefficient (SHGC)**

**5.5.4.4.1 SHGC of Vertical Fenestration**

*Vertical fenestration shall have an SHGC* not greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

**5.5.4.4.2 SHGC of Skylights**

*Skylights shall have an SHGC* not greater than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

## Amendments to 5.5.4.5 Fenestration Orientation

Amend Section 5.5.4.5 of ASHRAE 90.1-2019 as follows:

**5.5.4.5 Fenestration Orientation**

**Exceptions to 5.5.4.5**

[…]

4. Buildings where the west-oriented and east-oriented vertical fenestration area (as defined in Section [5.5.4.5](#_bookmark68)) does not exceed 20% of the gross wall area for each of those façades, and SHGC on those facades is no greater than 90% of the criteria in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5.

~~5. Buildings in Climate Zone 8.~~

## Amendments to 5.5.4.6 Visible Transmittance/SHGC Ratio

Amend Section 5.5.4.6 of ASHRAE 90.1-2019 as follows:

**5.5.4.6 Visible Transmittance/SHGC Ratio**

Where *automatic* daylighting *controls* are required in accordance with Section [9.4.1.1](#_bookmark280)(e) or (f), *fenestration* shall have a ratio of *VT* divided by *SHGC* not less than that specified in ~~Tables~~ [~~5.5-0~~](#_bookmark54) ~~through~~ [~~5.5-8~~](#_bookmark56)Table 5.5 for the appropriate *fenestration area*.

## Amendments to Section 5.9 Verification, Testing, and Commissioning

Amend Section 5.9 of ASHRAE 90.1-2019 as follows:

**5.9 Verification, Testing, and Commissioning~~, and Inspection~~**

**5.9.1 Verification and Testing**

**5.9.1.1 Building Envelope Performance Verification**

The *~~energy~~* ~~performance of the~~ *building envelope* shall be verified in accordance with ~~this s~~Sections 5.9.1.2 through 5.9.1.3 and Section 4.2.5.1.

**5.9.1.2 Verification of the Design and Installation of the Continuous Air Barrier**

Verification of the design and installation of the continuous air barrier shall be determined in accordance with the following by an independent third party when using Exception 3 of Section 5.4.3.1.1:

a. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2.

b. Periodic field inspection of the continuous air barrier materials and assemblies shall be conducted during construction while the *continuous air barrier* is still accessible for inspection and repair to verify and document compliance with the requirements of Sections 5.4.3.1.2 and 5.8.3.

c. Reporting Verification and *FPT* documentation shall comply with Section 4.2.5.1.2

**5.9.1.3 Dynamic Glazing**

*Dynamic glazing* operation shall be tested for conformance with the *manufacturer’s* installation instructions.

**5.9.2 Commissioning**

The *energy* performance of the *building envelope* shall be *commissioned* in accordance with Section 4.2.5.2. *Commissioning* reporting shall comply with Section 4.2.5.2.2.

**~~5.9.3 Inspections~~**

~~In addition to the requirements of Section 4.2.4, building envelope components and assemblies shall be inspected in accordance with Sections 5.9.13.1 through 5.9.13.4.~~

**~~5.9.3.1 Fenestration and Door Requirements~~**

*~~Fenestration~~* ~~and~~ *~~doors~~* ~~shall be inspected to verify compliance with the requirements of Sections 5.4.3.2, 5.8.2.1, 5.8.2.2, and 5.8.2.3. Where testing is required to demonstrate compliance with the air leakage requirements, it shall be conducted by an independent third party. Operation of the~~ *~~door~~* ~~and closers or operating mechanisms shall be inspected for conformance with the~~ *~~manufacturer’s~~* ~~instructions, and that the seals or gaskets are installed and in accordance with the~~ *~~manufacturer’s~~* ~~instructions.~~

**~~5.9.3.2 Inspection of Loading Dock Weatherseals~~**

~~Where there is a loading dock, weatherseals shall be inspected for proper installation and to verify that the seals are in good condition.~~

**~~5.9.3.3 Inspection of Opaque Building Envelope Air Tightness Requirements~~**

*~~Opaque roof~~*~~,~~ *~~above-grade walls~~* ~~and~~ *~~below-grade walls~~*~~, and~~ *~~floors~~*~~, shall be subject to the following inspections during~~ *~~construction~~*~~:~~

~~a.~~  ~~Use of compliant materials and assemblies as indicated in Section 5.8.3.1.~~

~~b.~~  ~~Integration with adjoining~~ *~~fenestration~~* ~~and~~ *~~continuous air barrier~~* ~~elements.~~

**~~5.9.3.4 Fenestration Inspections~~**

~~Fenestration shall be subject to the following inspections during~~ *~~construction~~*~~:~~

~~a.~~ ~~Skylights size and location in relation to the designed~~ *~~primary sidelighted area~~* ~~and~~ *~~secondary sidelighted area~~* ~~below.~~

~~b.~~ ~~Roof monitor size and location in relation to the designed primary sidelighted area and secondary sidelighted area below.~~

~~c.~~ ~~Dynamic glazing compliance with SHGC and U-factor in accordance with Sections 5.5.4.4.1 and 5.5.4.4.2, and testing of the operation for conformance with the~~ *~~manufacturer’s~~* ~~instructions.~~

~~d.~~ ~~Permanent~~ *~~fenestration~~* ~~projections installation and performance in accordance with Section 5.5.4.4.1 and the~~ *~~construction documents~~*~~.~~

## Amendments to Restructure Section 6.1.1.1 New Buildings, *etc.*

Amend Sections 6.1.1 through 6.1.5 of ASHRAE 90.1-2019 as follows:

**6.1** **General**

**6.1.1** **Scope**

Section 6 specifies requirements for mechanical *equipment* and *systems.*

**~~6.1.1.1~~ 6.1.2** **New Buildings**

Mechanical *equipment* and *systems* serving the heating, cooling, ventilating, or refrigeration needs of new *buildings* shall comply with the requirements of this section as described in Section 6.2

**~~6.1.1.2~~ 6.1.3** **Additions to Existing Buildings**

Mechanical *equipment* and *systems* serving the heating, cooling, ventilating, or refrigeration needs of additions to *existing buildings* shall comply with the requirements of this section as described in Section 6.2.

**Exception to ~~6.1.1.2~~ 6.1.3**

When HVACR to an *addition* is provided by existing HVACR *systems* and *equipment*, such *existing systems* and *equipment* shall not be required to comply with this standard. However, any new *systems* or *equipment* installed must comply with specific requirements applicable to those *systems* and *equipment*.

**~~6.1.1.3~~ 6.1.4** **Alterations to Heating, Ventilating, Air Conditioning, and Refrigeration ~~in Existing Buildings~~ Systems and Equipment**

**~~6.1.1.3.1~~ 6.1.4.1**

New HVACR *equipment* as a direct replacement of existing HVACR *equipment* shall comply with the following sections as applicable for the *equipment* being replaced:

1. ...

**~~6.1.1.3.2~~ 6.1.4.2**

New cooling *systems* installed to serve previously uncooled *spaces* shall comply with this section as described in Section 6.2.

**~~6.1.1.3.3~~ 6.1.4.3**

*Alterations* to existing cooling *systems* shall not decrease economizer capability unless the *system* complies with Section 6.5.1.

**~~6.1.1.3.4~~ 6.1.4.4**

New and replacement *ductwork* shall comply with Sections 6.4.4.1 and 6.4.4.2.

**~~6.1.1.3.5~~ 6.1.4.5**

New and replacement *piping* shall comply with Section 6.4.4.1.

**Exceptions to ~~6.1.1.3.5~~ 6.1.4.5**

Compliance shall not be required

1. ...

**~~6.1.2~~ 6.1.5** **Climate**

Climate zones shall be determined in accordance with Section ~~5.1.4~~ 5.1.5.

## Amendments to Restructure and Add Mechanical System Performance to Section 6.2 Compliance Paths, *etc.*

Amene Sections 6.2 and 6.3 of ASHRAE 90.1-2019 as follows:

**6.2 Compliance Paths**

Mechanical equipment and systems providing heating, cooling, ventilating, or refrigeration shall comply with Section 6.2.1 and Section 6.2.2.

**6.2.1** **Requirements for all Compliance Paths**

Mechanical equipment and systems shall comply with Section 6.1, “General”; Section 6.4, “Mandatory Provisions”; Section 6.7, “Submittals”; and Section 6.8, “Minimum *Equipment Efficiency* Tables.”

Exception to 6.2.1

When compliance is shown using Section 6.2.2(a), compliance with Section 6.4 is not required unless required in Section 6.3.2.

**6.2.2 Additional Requirements to Comply with Section 6**

Mechanical equipment and systems shall comply with one of the following:

1. Section 6.3, “Simplified Approach Building Compliance Path for *HVAC Systems*”

~~Exception to 6.2.2(a)~~

~~When compliance is shown using Section 6.2.2(a), compliance with Section 6.4 is not required.~~

1. Section 6.5, “Prescriptive Compliance Path”

Exception to 6.2.2(b)

*HVAC systems* only serving the heating, cooling, or ventilating needs of a *computer room* with IT *equipment* load greater than 10 kW shall be permitted to comply with Section 6.4, “Mandatory Provisions” and Section 6.6, “Alternative Compliance Path.”

1. Normative Appendix J “Mechanical *System* Performance Rating Method”

**Informative Note:**

Normative Appendix J requires certain allowable *systems* to meet the Appendix J requirements. All other systems shall meet requirements in Section 6.5.

* 1. **6.3 Simplified Approach Building Compliance Path for HVAC Systems**
     1. **Scope**

The simplified approach is an optional path for compliance when the following conditions are met:

1. The *building* is two stories or fewer in height.
2. *Gross floor area* is less than 25,000 ft2 (2300 m2)
3. Each *HVAC system* in the *building* complies with the requirements listed in Section 6.3.2.
   * 1. **Criteria**

The *HVAC system* must meet all of the following criteria:

1. The *system* serves a single *HVAC zone*.
2. The *equipment* must meet the variable flow requirements of Section 6.5.3.2.1.
3. Cooling (if any) shall be provided by a unitary packaged or split-*system* air conditioner that is either air cooled or evaporatively cooled, with *efficiency* meeting the requirements shown in Table 6.8.1-1 (air conditioners), Table 6.8.1-2 (heat pumps), or Table 6.8.1-4 (packaged *terminal* and *room air conditioners* and heat pumps) for the applicable *equipment* category. Cooling *equipment* shall also comply with Section 6.4.1.5.
4. The *system* shall have an *air economizer* meeting the requirements of Sections 6.5.1 and 6.4.3.12.
5. Heating (if any) shall be provided by a unitary packaged or split-*system* heat pump that meets the applicable *efficiency* requirements shown in Table 6.8.1-2 (heat pumps) or Table 6.8.1-4 (packaged *terminal* and *room air conditioners* and heat pumps), a *fuel*- fired furnace that meets the applicable *efficiency* requirements shown in Table 6.8.1-5 (furnaces, duct furnaces, and unit heaters), an *electric resistance* heater, or a baseboard *system* connected to a *boiler* that meets the applicable *efficiency* requirements shown in Table 6.8.1-6 (*boilers*). Heating *equipment* shall also comply with Section 6.4.1.5.
6. The *system* shall meet the exhaust air *energy* recovery requirements of Section 6.5.6.1.
7. The *system* shall be controlled by a *manual* changeover or dual *set-point thermostat*.
8. If a heat pump equipped with auxiliary internal *electric resistance* heaters is installed, *controls* shall be provided that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and *setback* recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles. The heat pump must be controlled by either (1) a digital or electronic *thermostat* designed for heat pump use that energizes auxiliary heat only when the heat pump has insufficient capacity to maintain *set point* or to warm up the *space* at a sufficient rate or (2) a multistage *space thermostat* and an *outdoor air thermostat* wired to energize auxiliary heat only on the last stage of the *space thermostat* and when *outdoor air* temperature is less than 40°F (4.4°C).
9. The *system controls* shall not permit *reheat* or any other form of simultaneous heating and cooling for humidity *control*.

**Exception to 6.3.2.(i)**

Humidity control assisted by hot-gas reheat or heat from 100% *site-recovered energy*.

1. *Systems* serving *spaces* other than ~~hotel/motel guest rooms~~ *residential spaces*, ~~and other than those~~ that do not require ~~ing~~ continuous operation~~, which have both~~ with a cooling or heating capacity greater than ~~15,000~~ 7,000 Btu/h (2.1 kW) ~~and a supply fan motor power greater than 0.75 hp~~, ~~shall be provided with a time clock that (1) can start and stop the~~ *~~system~~* ~~under different schedules for seven different day types per week, (2) is capable of retaining programming and time setting during a loss of power for a period of at least ten hours, (3) includes an accessible~~ *~~manual~~* ~~override that allows temporary operation of the~~ *~~system~~* ~~for up to two hours, (4) is capable of and configured with temperature~~ *~~setback~~* ~~down to 55°F during off hours, and (5) is capable of capable of and configured with temperature setup to 90°F during off hours.~~  shall comply with Section 6.4.3.3.1 and 6.4.3.3.2.
2. *Systems* serving *residential spaces* other than hotel/motel guest rooms shall comply with Section 6.4.3.3.1 and 6.4.3.3.2 except for electric resistance heaters rated at 1.5 kW or less with a *readily accessible* *manual control* that lowers the setpoint or turns the unit off.

1. The system shall comply with the demand control ventilation requirements in Section 6.4.3.8 and the ventilation design requirements in Section 6.5.3.~~7~~8.
2. The *system* complies with the *door* switch requirements in Section 6.5.10.

## Amendments to Mandatory Requirements

Section 6.4 ASHRAE 90.1-2019 shall be amended to read as follows:

**6.4.1.1 Minimum Equipment *Efficiencies*—Listed Equipment—Standard Rating and Operating Conditions**

*Equipment* shown in Tables 6.8.1-1 through 6.8.1-21~~20~~ shall have a minimum performance at the specified rating conditions when tested in accordance with the specified test procedure. Where multiple rating conditions or performance requirements are provided, the *equipment* shall satisfy all stated requirements unless otherwise exempted by footnotes in the table. *Equipment* covered under the Federal *Energy* Policy Act of 1992 (EPACT) shall have no minimum *efficiency* requirements for operation at minimum capacity or other than standard rating conditions. *Equipment* used to provide *service water-heating* functions as part of a

combination system shall satisfy all stated requirements for the appropriate *space* heating or cooling category.

**~~6.4.1.3 Ceiling Fans~~**

*~~Large-diameter ceiling fans~~* ~~shall be rated in accordance with 10 CFR 430 Appendix U or AMCA 230. The following data shall be provided:~~

~~a. Blade span (blade tip diameter)~~

~~b. Rated airflow and power consumption at the maximum speed~~

~~Informative Note: See Informative Appendix F for the U.S. Department of Energy requirements for US applications.~~

~~6.4.1.3.1~~

~~The data provided shall meet one of the following requirements:~~

~~a. It is determined by an independent laboratory.~~

~~b. It is included in a database published by USDOE.~~

~~c. It is certified under a program meeting the requirements of Section 6.4.1.5.~~

~~Exception to 6.4.1.3.1~~

*~~Ceiling fans~~* ~~not covered in the scope of 10 CFR Part 430.~~

**Exceptions to 6.4.3.3**

1. *HVAC systems* intended to operate continuously.

2. *HVAC systems* not serving *residential spaces* and having a design heating capacity and cooling capacity less than ~~15,000~~ 7,000 Btu/h (2.1 kW) that are equipped with a *readily accessible manual* on/off *control~~s~~.*

**6.4.3.3.1 Automatic Shutdown**

*HVAC systems* shall be equipped with at least one of the following:

a. *Controls* that can start and stop the *system* under different time schedules for seven different day types per week, are capable of retaining programming and time setting during loss of power for a period of at least ten hours, and include an accessible *manual* override or equivalent function that allows temporary operation of the *system* for up to two hours.

b. An *occupancy sensor* that is capable of shutting the *system* off when no occupant is sensed for a period of up to 30 minutes.

c. A manually operated timer capable of being adjusted to operate the *system* for up to two hours.

d. An interlock to a security *system* that shuts the *system* off when the security *system* is activated.

**Exceptions to 6.4.3.3.1**

1. Systems serving *Residential* occupancies with ~~may use~~ *controls* that can start and stop the *system* under at least two different time schedules per week.

2. Systems serving non-*residential* occupancies where heating or cooling capacity is less than 15,000 Btu/hour (4.4 kW) with controls that can start and stop the *system* under at least two different time schedules per week.

**6.4.3.3.2 Setback Controls**

Heating *systems* shall be equipped with *controls* capable of and configured to *automatically* restart and temporarily operate the *system* as required to maintain zone temperatures above an adjustable heating *set point* at least 10°F below the occupied heating *set point*. Cooling *systems* shall be equipped with *controls* capable of and configured to *automatically* restart and temporarily operate the *mechanical cooling system* at the lowest practical fan speedas required to maintain zone temperatures below an adjustable cooling *set point* at least 5°F above the occupied cooling *set point* or to prevent ~~high~~ maximum *space* humidity levels as required by Standard 62.1.

**Exception to 6.4.3.3.2**

*Radiant heating systems* capable of and configured with a *setback* heating *set point* at least 4°F below the occupied heating *set point*.

**6.4.3.3.3 Optimum Start Controls**

Individual heating and cooling *systems* with *setback controls* and *DDC* shall have *optimum start controls*. The *control* algorithm shall, as a minimum, be a function of the difference between *space* temperature and occupied *set point*, the outdoor temperature, and the amount of time prior to scheduled occupancy. Mass radiant *floor* slab *systems* shall incorporate *floor* temperature into the optimum start algorithm.

**Exception to 6.4.3.3.3*:*** *Residential spaces* are not required to have *optimum start controls*.

**Exceptions to 6.4.3.3.5.1**

1. A *networked guest room control system* shall be permitted to return the *thermostat set points* to their default occupied *set points* 60 minutes prior to the time the room is scheduled to be occupied.

2. ~~Cooling for humidity~~ *~~control~~* ~~shall be permitted during rented and unoccupied or unrented and unoccupied periods.~~ Dehumidification shall be permitted to limit the *space* humidity levels as required by Standard 62.1 during unoccupied mode for both rented and unrented periods.

**6.4.3.4.1 Stair and Elevator Shaft Vent Dampers**

Where s~~S~~tair and elevator shafts have vents, they shall be equipped with motorized dampers that are capable of and configured to *automatically* close during normal *building* operation and are interlocked to only open as required by fire and smoke detection systems, or by *thermostatic control systems*.

**Exception to 6.4.3.4.1**

Nonmotorized gravity back draft dampers are acceptable in *buildings* less than three stories in height and for *buildings* of any height located in Climate Zones 0, 1, 2, and 3.

**6.4.3.4.2 Shutoff Damper Controls**

All *outdoor air* intake and exhaust *systems* shall be equipped with motorized dampers that will *automatically* shut when the *systems* or *spaces* served are not in use. *Outdoor air* and exhaust/relief dampers shall be capable of and configured to *automatically* shut off during preoccupancy *building warm-up*, *cooldown*, and *setback*, except when the supply of *outdoor air* reduces *energy* costs or when *outdoor air* must be supplied to meet code requirements.

**Exceptions to 6.4.3.4.2**

1. Nonmotorized ~~(~~gravity back draft~~)~~ dampers are acceptable for exhaust and relief in *buildings* less than three stories in height and for *outdoor air* intakes and exhaust and relief dampers in *buildings* of any height located in Climate Zones 0, 1, 2, and 3. Nonmotorized dampers for *outdoor air* intakes must be protected from direct exposure to wind.

**6.4.3.4.5 ~~Enclosed~~ Parking Garage Ventilation Systems**

~~Enclosed~~ ~~p~~Parking garage *ventilation* *systems* shall meet all of the following:

1. Separate *ventilation* *systems* and *control systems* shall be provided for each *parking garage section*.
2. *Control systems* for each *parking garage section* shall *automatically* detect and control contaminant levels and ~~stage fans or modulate~~ shall be capable of and configured to reduce fan airflow ~~rates~~ to ~~50%~~ 20% or less of *design capacity*, provided acceptable contaminant levels are maintained.
3. The *ventilation* *system* for each *parking garage section* shall have *controls* and devices that result in fan motor *demand* of no more than 30% of design wattage at 50% of the design airflow.

**Exceptions to 6.4.3.4.5**

~~1.~~ Garage~~s~~ *ventilation systems* serving a single *parking garage section* having a total *ventilation system motor nameplate horsepower* (kilowatts)notexceeding 5 hp (3.7 kW) at *fan system design conditions* ~~less than 30,000 ft~~~~2~~ ~~with~~ *~~ventilation~~**~~systems~~* and where the *parking garage section* has no *mechanical cooling* or *mechanical heating*.

~~2. Garages that have a garage area to~~ *~~ventilation system motor nameplate horsepower~~* ~~ratio that exceeds 1500 ft~~~~2~~~~/hp and do not utilize~~ *~~mechanical cooling~~* ~~or mechanical heating.~~

~~3. Where not permitted by the authority having jurisdiction.~~

**6.4.3.9 Heated or Cooled Vestibules**

Heating *systems* for vestibules ~~and for air curtains units with integral heating~~ shall include *automatic controls* capable of and configured to shut off the heating *system* when *outdoor air* temperatures are above 45°F (7.0°C). Vestibule heating and cooling *systems* shall be controlled by a *thermostat* in the vestibule capable of and configured to limit heating to a maximum of 60°F (16°C) and cooling to a minimum of 85°F (29°C).

*Modify the standard as follows (IP Units)*

**6.4.5 Walk-In Coolers and Walk-In Freezers**

j. Antisweat heater *controls* shall reduce the *energy* use of the antisweat heater as a function of the ~~relative~~ humidity in the air outside the *door* or in response to the condensation on the inner glass pane.

**6.4.6 Refrigerated Display Case**

d. Antisweat heater *controls* shall reduce the *energy* use of the antisweat heater as a function of the ~~relative~~ humidity in the air outside the *door* or in response to the condensation on the inner glass pane.

**6.4.8 Dehumidification in spaces for plant growth and maintenance**

Equipment that dehumidifies *indoor grow* and *greenhouse* spaces shall be one or more of the following:

|  |
| --- |
| 1. *Dehumidifiers* tested in accordance with the test procedure listed in DOE 10 CFR 430 and DOE 10 CFR 430, Subpart B, Appendix X or X1. 2. *Integrated HVAC system* with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat; 3. Chilled water system with on-site heat recovery designed to fulfill not less than 75 percent of the annual energy for dehumidification reheat; or 4. Solid or liquid *desiccant dehumidification system* for system designs that require dewpoint of not more than 50°F (10°C). |

## Amendments to Economizers, Energy Recovery, Renewable Energy, Low Power Fans, and Controls

Amend Table 6.5.1-2 and Sections 6.5.1-6.5.3 of ASHRAE 90.1-2019 as follows:

|  |  |
| --- | --- |
| **Table 6.5.1-2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling *Efficiency*** | |
| **Climate Zone** | ***Efficiency* Improvementa** |
| 2A | 17% |
| 2B | 21% |
| 3A | 27% |
| 3B | 32% |
| 3C | 65% |
| 4A | 42% |
| 4B | 49% |
| 4C | 64% |
| 5A | 49% |
| 5B | 59% |
| 5C | 74% |
| 6A | 56% |
| 6B | 65% |
| 7 | 72% |
| 8 | 77% |
| 1. If a unit is rated with an annualized or part-load metric~~IPLV, IEER, or SEER~~, then to eliminate the required economizer, only the annualized or part-load minimum cooling ~~efficiency~~ *efficiency* of the ~~HVAC~~ unit must be increased by the percentage shown. If the ~~HVAC~~ unit is only rated with a full-load metric like EER cooling, then these must be increased by the percentage shown. To determine the *efficiency* required to eliminate the economizer when the unit *equipment efficiency* is rated with an energy-input divided by a thermal-output metric, the metric shall first be converted to COP by the *efficiency* improvement percentage shown. The COP shall then be converted back to the original rated metric to establish the efficiency required to eliminate the economizer. | |
| Informative note: Some examples of annualized or part-load metrics are: IPLV.IP, IEER, and SEER. | |

*Modify the standard as follows (SI Units)*

*Table same as I-P version*

|  |
| --- |
| a.If a unit is rated with an annualized or part-load metric~~IPLV, ICOP, or SEER~~, then to eliminate the required economizer, only the annualized or part-load minimum cooling efficiency of the ~~HVAC~~unit must be increased by the percentage shown. If the ~~HVAC~~unit is only rated with a full-load metric like COP cooling, then these must be increased by the percentage shown. |
| Informative note: Some examples of annualized or part-load metrics are: IPLV.SI, ISCOPC, and SCOPC. |

**~~6.4.5 Walk-In Coolers and Walk-In Freezers~~**

~~j. Antisweat heater~~ *~~controls~~* ~~shall reduce the~~ *~~energy~~* ~~use of the antisweat heater as a function of the relative humidity in the air outside the~~ *~~door~~* ~~or in response to the condensation on the inner glass pane.~~

**~~6.4.6 Refrigerated Display Case~~**

~~d. Antisweat heater~~ *~~controls~~* ~~shall reduce the~~ *~~energy~~* ~~use of the antisweat heater as a function of the relative humidity in the air outside the~~ *~~door~~* ~~or in response to the condensation on the inner glass pane.~~

**6.5.1.1.5 Relief of Excess Outdoor Air**

**a.** *Systems* shall provide ~~a~~ one of the following means to relieve excess *outdoor air* during *air economizer* operation to prevent over pressurizing the *building*~~.~~:

1. Return or relief fan(s) meeting the requirements of section 6.5.3.2.4.

2. Barometric or motorized damper relief path with a total pressure drop at design relief airflow rate less than 0.10 inches water column (25 Pa) from the occupied *space* to outdoors. Design relief airflow rate shall be the design supply airflow rate minus any continuous exhaust flows, such as toilet exhaust fans, whose makeup is provided by the economizer system.

**b.** The relief air outlet shall be located so as to avoid recirculation into the *building*.

**6.5.2.1 exception 4;** Zones where at least 75% of the *energy* for *reheating* or for providing warm air in mixing *systems* is provided from *site-recovered energy* (including condenser heat) or *~~site-solar energy~~ on-site renewable energy.*

**6.5.2.3 exception 4;** *Systems* serving *spaces* where specific humidity levels are required to satisfy process needs, such as a vivarium; museum; surgical suite; pharmacy; and *buildings* with refrigerating *systems*, such as supermarkets, refrigerated warehouses, and ice arenas, and where the *building* includes *site-recovered energy* or *~~site-solar energy~~ on-site renewable energy* that provide *energy* equal to at least 75% of the annual *energy* for *reheating* or for providing warm air in mixing *systems*. This exception does not apply to *computer rooms*.

**6.5.2.3 exception 5:** At least 90% of the annual *energy* for *reheating* or for providing warm air in mixing *systems* is provided from *site-recovered energy* (including condenser heat) or *~~site-solar energy~~* *on-site renewable energy.*

**6.5.2.6 Ventilation Air Heating Control**

Units that provide *ventilation* air to multiple zones and operate in conjunction with zone heating and cooling *systems* shall not use heating or heat recovery to warm supply air above 60°F [16°C] when representative *building* loads or *outdoor air* temperature indicate that the majority of zones require cooling*.*

**Exception to 6.5.2.6:** Units that heat the airstream using only *series energy recovery* when representative *building* loads or *outdoor air* temperature indicate that the majority of zones require cooling in Climate Zones 0A, 1A, 2A, 3A, and 4A.

**6.5.3.5 exception 3;** *Systems* in which at least 75% of the *energy* for *reheating* (on an annual basis) is from *site recovered energy* or *~~site-solar energy~~ on-site renewable energy.*

**6.5.6.1 exception 3;** Where more than 60% of the *outdoor air* heating *energy* is provided from *site-recovered energy* or *~~site-solar energy~~ on-site renewable energy.*

**6.5.6.2.2 exception 2;** Facilities that provide 60% of their *service water heating* from *~~site-solar energy~~* *on-site renewable energy* or *site-recovered energy* or from other sources

**6.5.3.7 Low Power Fans**

Fans that are not covered by Section 6.5.3.6 and having a *fan nameplate electrical input power* of less than 180 W or having a motor *nameplate horsepower* less than 1/12 HP (62.1 W) shall meet the fan efficacy requirements of Table 6.5.3.7 at one or more rating points.

**Table 6.5.3.7 Minimum Fan Efficacy for Low Power Fans**

|  |  |  |
| --- | --- | --- |
| **System Type** | **Minimum Fan Efficacya, b, cfm/W (l/s/W)** | **Test method and rating conditions** |
| HRVc, ERVd, or other  system with exhaust air energy recovery | 1.2 (0.57) | CAN/CSA 439-18 |
| Transfer fans; in-linee supply or exhaust fan | 3.8 (1.8) | ASHRAE Standard 51 |
| Other exhaust fan,  < 90 cfm (42.5 l/s) | 2.8 (1.3) |
| Other exhaust fan,  ≥ 90 cfm (42.5 l/s)  and  ≤ 200 cfm (94.4 l/s) | 3.5 (1.7) |
| Other exhaust fan,  > 200 cfm (94.4 l/s) | 4.0 (1.9) |

1. Fan efficacy is the volumetric fan airflow rate divided by total fan motor electrical input power at a specified static pressure difference.
2. Fans shall be testedin accordance with the referenced test method. Fan efficacy shall be reported in the product listing or shall be derived from the fan motor electrical input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV or ERV, balanced, and in-line fans shall be determined at a static pressure difference not less than 0.2 in. of H2O (50 Pa) for each airstream. Fan efficacy for other ducted fan systems shall be determined at a static pressure difference not less than 0.1 in. of H20 (25 Pa).
3. A heat recovery ventilator (HRV) isa mechanically powered ventilating device with separate intake and exhaust air streams and a heat exchanger to transfer a portion of the sensible energy, heat, from one air stream to the other.
4. An energy recovery ventilator (ERV) isa mechanically powered ventilating device with separate intake and exhaust air streams and a heat exchanger to transfer a portion of the total energy, heat and moisture, from one air stream to the other.
5. An in-line fan isan exhaust or supply fan installed with ductwork on both the fan inlet and outlet.

**Exceptions to 6.5.3.7**

1. Fans in *space*-conditioning *equipment*.

2. Intermittently operating dryer exhaust duct power ventilators, domestic range hoods, and domestic range booster fans.

3. Fans in radon mitigation systems.

4. Fans not covered within the scope of the test methods referenced in Table 6.5.3.7.

5. Ceiling fans regulated under 10 CFR 430 Appendix U.

**6.5.3.~~7~~8 Ventilation Design**

The required minimum *outdoor air* rate is the larger of the minimum *outdoor air* rate or the minimum exhaust air rate required by Standard 62.1, Standard 62.2, Standard 170, or applicable codes or accreditation standards. *Outdoor air ventilation systems* shall comply with one of the following:

a. Design minimum *system outdoor air* provided shall not exceed 135% of the required minimum *outdoor air* rate.

b. Dampers, *ductwork*, and *controls* shall be provided that allow the *system* to supply no more than the required minimum *outdoor air* rate with a single *set-point* adjustment.

c. The *system* includes exhaust air *energy* recovery complying with Section 6.5.6.1.

**6.5.3.~~8~~9 Occupied-Standby Zone Controls**

Zones serving only rooms that are required to have automatic partial OFF or automatic full OFF lighting controls per Section 9.4.1.1, where the ASHRAE Standard 62.1 occupancy category permits ventilation air to be reduced to zero when the space is in occupied-standby mode, and when using the Ventilation Rate Procedure, shall meet the following within five (5) minutes of all rooms in that zone entering occupied-standby mode.

a. Active heating set point shall be setback at least 1°F (0.5 °C).

b. Active cooling set point shall be setup at least 1°F (0.5 °C).

c. All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

**6.5.3.9.1 Occupied-Standby Control of Multiple-Zone Systems**

Multiple-zone *systems* that are capable of resetting the minimum *outdoor air* setpoint and that serve zones with occupied-standby zone controls, shall reset the minimum *outdoor air* setpoint based on a zone *outdoor air* requirement of zero for all zones in occupied-standby mode.

**Exception to 6.5.3. ~~8~~9**

Multiple-zone *systems* without automatic zone flow control dampers.

***Informative Note***

ASHRAE Guideline 36 includes sequences for this reset.

## Ceiling Fan Efficiency Requirements Moved to Table 6.8.1-21

Table 6.8.1-21 is added to ASHRAE 90.1-2019 to read as follows:

**Table 6.8.1-21 Ceiling Fan *Efficiency* Requirementsa**

|  |  |  |  |
| --- | --- | --- | --- |
| Equipment Type | Size Category | Minimum *Efficiency*b | Test Procedurec |
| *Large diameter ceiling fan* for applications outside the U.S. | Blade span ≥84.5 in. (2.15m) | *CFEI* ≥ 1.00 at high (maximum) speed  *CFEI* ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed | 10 CFR 430 Appendix U or AMCA Standard 230 and AMCA Standard 208 |

1. The minimum *efficiency* requirements at both high speed and 40% of maximum speed must be met or exceeded to comply with this standard.
2. *Ceiling fans* are regulated in the U.S. as consumer products under 10 CFR 430. For U.S. applications of large diameter ceiling fans, refer to Informative Appendix F, Table F-6, for the US DOE minimum *efficiency* requirements.
3. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

## Amendments to Verification, Testing, and Commissioning

Amend Section 6.9 of ASHRAE 90.1-2019 as follows:

**6.9 Verification, Testing, and Commissioning**

**6.9.1 Verification and Testing**

HVAC *control systems* shall be tested in accordance with this section and ~~provisions of~~ Section 4.2.5.1. Testing shall verify that systems and control elements are calibrated, adjusted, configured, and operating in accordance with applicable requirements of Sections 6.3, 6.4, and 6.5. Verification and *~~FTP~~ FPT* documentation shall comply with Section 4.2.5.1.2.

**6.9.2 Commissioning**

The performance of the *mechanical systems* shall be commissioned in accordance with Section 4.2.5.2. ~~Detailed instructions for~~ *~~commissioning HVAC system~~*~~s shall be provided in the~~ *~~construction documents~~*~~.~~ *Commissioning* reporting shall comply with Section 4.2.5.2.2.

## Amendments to Restructure 7.1.1.1 Water Heating Compliance

Amend Section 7.1 of ASHRAE 90.1-2019 as follows:

**7.1 General**

**7.1.1. Service Water-Heating Scope**

Section 7 specifies requirements for *Service water-heating systems* and *equipment.*

**~~7.1.1.1~~ 7.1.2 New Buildings**

*Service water-heating systems* and *equipment* shall comply with the requirements of ~~this section as described in~~ Section 7.2.

**~~7.1.1.2~~ 7.1.3 Additions to Existing Buildings**

*Service water-heating systems* and *equipment* shall comply with the requirements of ~~this~~ Section 7.2.

Exception to ~~7.1.1.2~~ 7.1.3

When the *service water heating* to an *addition* is provided by existing *service water-heating systems* and *equipment*, such *systems* and *equipment* shall not be required to comply with this standard. However, any new *systems* or *equipment* installed must comply with specific requirements applicable to those *systems* and *equipment*.

**~~7.1.1.3~~ 7.1.4 Alterations to ~~Existing Buildings~~ *Service water-heating systems* and *equipment***

*Building service water-heating equipment* installed as a direct replacement for *existing building service water-heating equipment* shall comply with the requirements of Section 7 applicable to the *equipment* being replaced. New and replacement *piping* shall comply with Section 7.4.3.

Exception to ~~7.1.1.3~~ 7.1.4

Compliance shall not be required where there is insufficient *space* or access to meet these requirements.

## Pool Heating Exception Clarification

Amend Exception to Section 7.4.5.2 of ASHRAE 90.1-2019 as follows:

**7.4.5.2 exception;** *Pools* deriving over 60% of the *energy* for heating from *site-recovered energy* or *~~site-solar energy~~* *on-site renewable energy*.

## Amendments to Large Service Water-Heating Systems

Amend Section 7.5.3 of ASHRAE 90.1-2019 as follows:

**7.5.3** **Large ~~Buildings with High-Capacity~~ Service Water-Heating Systems**

New *buildings* with ~~gas~~ *service water-heating systems* with a total installed ~~gas~~ *~~water-heating~~* input capacity of 1,000,000 Btu/h (293 *kW*)or greater~~,~~ provided by high-capacity ~~shall have~~ gas-fired *service water-heating* *equipment* shall meet either or both of the following requirements:

1. Where a single unit of high-capacity gas-fired *service water-heating equipment* is installed, it shall have ~~with~~ a minimum thermal *efficiency* (*~~Et~~* Et) of 92~~0~~%.
2. Multiple units of high-capacity gas-fired *service* ~~water-heating~~ *water-heating equipment* connected to the same *service water-heating system* shall have a~~are allowed to meet this requirement if the water-heating input provided by~~ *~~equipment~~* ~~with thermal~~ *~~efficiency~~* ~~(~~*~~Et~~*~~) above and below 90% provides an~~ total input capacity-weighted average thermal *efficiency* (Et) of at least 90% and a minimum of 30% of the input of the high-capacity gas-fired *service water-heating equipment* in the *service water heating-system* shall have a thermal *efficiency* (Et) of at least 92%.

High-capacity gas-fired *service water-heating equipment* is comprised of gas-fired instantaneous *water heaters* with a rated input both greater than 200,000 Btu/h (58.6 *kW*) and not less than 4,000 Btu/h per gallon (310 W per liter) of stored water, and gas-fired storage *water heaters* with a rated input both greater than 105,000 Btu/h (30.8 *kW*) and less than 4,000 Btu/h per gallon (310 W per liter) of stored water.

Exception to 7.5.3

1. ~~Where 25% of the annual~~ *~~service water-heating~~* ~~requirement is provided by~~ *~~on-site renewable energy~~* ~~or~~ *~~site-recovered energy~~*~~.~~

~~2~~1. *Water heaters* installed in individual *dwelling units*.

~~3~~2. Individual gas *water heaters* with input capacity not greater than 100,000 Btu/h (29.3 *kW*).

## Amendments to Verification, Testing, and Commissioning

Amend Section 7.9 of ASHRAE 90.1-2019 as follows:

**7.9 Verification, Testing, and Commissioning**

**7.9.1 Verification and Testing**

Service hot-water controls shall be verified and tested in accordance with this section and ~~provisions of~~ Section 4.2.5.1. Testing shall verify that *systems* and *controls* are configured and operating in accordance with applicable requirements of:

a. *service water heating system* temperature controls (Sections 7.4.4.1 and 7.4.4.3),

b. recirculation pump or *heat trace* controls (Section 7.4.4.2), or *pool* time switch controls (Section 7.4.5.3).

c. Verification and *~~FTP~~FPT* documentation shall comply with Section 4.2.5.1.2.

**7.9.2 Commissioning**

The *energy* performance of the s*ervice water heating systems* shall be *commissioned* in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.

## Amendments to Section 8.1 General

Amend Section 8.1 of ASHRAE 90.1-2019 as follows:

**8.1 General**

**8.1.1 Scope**

This section applies to all *building* power *distribution systems* and only to *equipment* described below.

**8.1.2 New Buildings**

*Equipment* installed in new *buildings* shall comply with the requirements of ~~this~~ Section 8.2.

**8.1.3 Addition to Existing Buildings**

Equipment installed in additions to existing buildings shall comply with the requirements of ~~this~~ Section 8.2.

**8.1.4 Alterations to ~~Existing Buildings~~ building power distribution systems and equipment**

Exception to 8.1.4

Compliance shall not be required for the relocation or reuse of existing equipment at the same site.

**8.1.4.1**

*Alterations* to *building service equipment* ~~or~~ and *systems* shall comply with the requirements of ~~this~~ Section 8 as applicable to those specific portions of the *building* and its *systems* that are being altered.

**8.1.4.2**

Any new *equipment* subject to the requirements of ~~this~~ Section 8 that is installed in conjunction with the alterations as a direct replacement of *existing equipment* shall comply with the specific requirements applicable to that *equipment*.

## Amendments to Electrical Energy Monitoring

Amend Section 8.4.3.2 of ASHRAE 90.1-2019 as follows:

**8.4.3 Electrical Energy Monitoring**

**8.4.3.1 Monitoring**

[…]

f. *Electric vehicle* charging

[…]

**Exceptions to Sections 8.4.3.1 and 8.4.3.2**

1. *Buildings* less than ~~25,000~~ 10,000 ft2 of conditioned floor area.

2. Individual tenant *spaces* less than ~~10,000~~ 5,000 ft2.

[…]

6. *Existing buildings.*

## Amendments to Low-Voltage Dry-Type Distribution Transformers

Amend Section 8.4.4 of ASHRAE 90.1-2019 as follows:

**8.4.4 Low-Voltage Dry-Type Distribution Transformers**

Low-voltage *~~dry-type~~*dry-typedistribution *transformers* shall comply with ~~the provisions of the Energy Policy~~

~~Act of 2005, where applicable, as shown~~ the requirements shown in Table 8.4.4. *Transformers* that are not included in ~~the scope of~~ the definition of distribution *transformers* as defined in 10 CFR 431.192~~Energy Policy Act of 2005~~ have no performance requirements in this section and are listed for ease of reference as exceptions.

**Exception to 8.4.4**

*Transformers* that meet any of the following exclusions in the DOE definition of Distribution Transformers found in 10 CFR 431.192~~of the Energy Policy Act of 2005 based on 10 CFR 431 definition~~:

1. ~~Special purpose applications.~~
2. ~~Not likely to be used in general purpose applications.~~
3. *Transformers* with tap range of 20 percent or more ~~multiple voltage taps, where the highest tap is at least 20% more than the lowest tap~~.
4. Drive (isolation) *transformer*.
5. Rectifier *transformer*.
6. Auto-*transformer*.
7. Uninterruptible power *supply transformer*.
8. Special impedance *transformer*.
9. Regulating *transformer*.
10. Sealed *transformer*.
11. Machine-tool (control) *transformer*.
12. Welding *transformer*.
13. Grounding *transformer*.
14. Testing *transformer*.
15. Nonventilated *transformer*

…

**Table 8.4.4 Minimum Nominal *Efficiency* Levels for Low-Voltage Dry-Type Distribution *Transformers*a,b**

**Single-Phase *Transformers***  Three-Phase ***Transformers***

**kVA~~b~~c**  **Efficiency,%~~c~~d**  **kVA~~b~~c**  **Efficiency,%~~c~~d**

…

a. A low-voltage dry-type distribution *transformer* is a *transformer* that is air-cooled, does not use oil as a coolant, has an input voltage < 600 V, and is rated for operation at a frequency of 60 Hz.

b. A low-voltage dry-type distribution *transformer* with a kVA rating not listed in the table shall have its minimum efficiency level determined by linear interpolation of the kVA and efficiency values listed in the table immediately above and below its kVA rating. Extrapolation shall not be used below the minimum values or above the maximum values shown for single-phase *transformers* and three-phase *transformers*.

~~b~~c. *Kilovolt-ampere* rating.

~~c~~d. Nominal efficiencies shall be established in accordance with the 10 CFR 431.193 test procedure for low-voltage *~~dry-type~~* dry-type distribution *transformers*.

*(rest of the section is unchanged)*

## Amendments to Verification, Testing, and Commissioning

Amend Section 8.9 of ASHRAE 90.1-2019 as follows:

**8.9 Verification, Testing, and Commissioning**

**8.9.1 Verification and Testing**

*Building* power *distribution systems* and applicable *equipment ~~Automatic~~* ~~receptacles controls (Section 8.4.2) and~~ *~~energy~~* ~~monitoring (Section 8.4.3)~~ shall be verified and tested in accordance with this section and ~~provisions of~~ Section 4.2.5.1. Testing shall verify that control elements are configured and operating in accordance with applicable requirements of:

a. *automatic* receptacles controls (Sections 8.4.2) ~~and~~.

b. *energy* monitoring (8.4.3).

c. Verification and *FPT* documentation shall comply with Section 4.2.5.1.

**8.9.2 Commissioning**

The *energ*y performance of the power *systems* shall be *commissioned* in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.

## Amendments to 9.1.1 Lighting Scope Exception

Amend Section 9.1.1 of ASHRAE 90.1-2019 as follows:

**9.1.1 Scope**

This section shall apply to the following:

a. Interior spaces of buildings.

b. Exterior lighting that is powered through the building's electrical service.

**Exception to 9.1.1**

1. Emergency lighting that is automatically off during normal building operation.

2. Lighting, including exit signs, that is specifically designated as required by a health or life safety statute, ordinance, or regulation.

~~3. Decorative gas lighting systems.~~

## Amendments to Restructure and Clarify 9.1.2 Lighting Alterations

Amend Section 9.1.2 of ASHRAE 90.1-2019 as follows:

**9.1.2 Lighting Alterations**

~~For the~~ *~~alteration~~* ~~of any~~ *~~lighting system~~* ~~in an interior~~ *~~space~~*~~, that~~ *~~space~~* ~~shall comply with the~~ *~~lighting power density~~* ~~(~~*~~LPD~~*~~) allowances of Section 9.5.1 or 9.6.1 and the~~ *~~control~~* ~~requirements of Section 9.4.1.1 (a), (b), (c), (d), (g), (h), and (i), as applicable to that~~ *~~space~~*~~.~~

~~For the~~ *~~alteration~~* ~~of any~~ *~~lighting system~~* ~~for the exterior of a~~ *~~building~~* ~~application, that~~ *~~lighting system~~* ~~shall comply with the~~ *~~lighting power density~~* ~~(~~*~~LPD~~*~~) allowances of Section 9.4.2 applicable to the area illuminated by that~~ *~~lighting system~~* ~~and the applicable~~ *~~control~~* ~~requirements of Sections 9.4.1.4 and 9.4.2.~~

The *alteration* of a *lighting system* in an interior *space* shall comply with Section 9.1.2.1. The *alteration* of a *lighting system* in an exterior area shall comply with Section 9.1.2.2.

**~~Exceptions to 9.1.2~~**

~~1.~~ *~~Alterations~~* ~~that involve 20% or less of the connected lighting load in a~~ *~~space~~* ~~or area need not comply with these requirements, provided that such~~ *~~alterations~~* ~~do not increase the installed lighting power.~~

~~2. Lighting~~ *~~alterations~~* ~~that only involve replacement of~~ *~~lamps~~* ~~plus~~ *~~ballasts~~*~~/~~*~~drivers~~* ~~or only involve one-for-one~~ *~~luminaire~~* ~~replacement need only comply with~~ *~~LPD~~* ~~requirement and Section 9.4.1.1(h) or 9.4.1.1(i).~~

~~3. Routine maintenance or~~ *~~repair~~* ~~situations.~~

The maintenance of an existing *lighting system* to return it to working order shall not be considered an *alteration*. Retrofitting a *luminaire* for which the original *lamps* and *ballast/driver* are replaced with a new *lamp/light source* and *driver*/*ballast* that was not a component of the original *luminaire* shall be considered an *alteration*.

**9.1.2.1 Lighting Alterations for Interior Building Spaces**

The *alteration* of a *lighting system* in an interior *space* shall meet one of the following:

1. The *alteration* shall comply with Section 9.2 when the total wattage of all new and retrofitted *luminaires* is greater than 2000 watts.
2. When the total wattage of all new and retrofitted *luminaires* is 2000 watts or less, each altered space shall comply with the *LPA* of Table 9.6.1 and Section 9.6.2, or the *alteration* shall result in a new wattage at least 50% below the original wattage of each altered *lighting system*. Additionally, the new and retrofitted lighting shall comply with the control requirements of Sections 9.4.1.1(a), 9.4.1.1(h), 9.4.1.1(i) as applicable to each altered *space* as shown on Table 9.6.1 and Section 9.6.2.

**9.1.2.2 Lighting Alterations for Exterior Building Areas**

The *alteration* of a *lighting system* for an exterior area shall use only the area specific allowances in Table 9.4.2-2 and shall not use the Base Site Allowances to determine the *LPA*. Additionally, the exterior alteration shall meet one of the following:

1. The *alteration* shall comply with Section 9.2 when the total number of new and retrofitted *luminaires* is greater than 10, or where the combined length of new and retrofitted linear *luminaires* is greater than 20 linear feet (6.1 linear meters).
2. Where the total number of new and retrofitted *luminaires* is not greater than 10 or where the combined length of new and retrofitted linear *luminaires* is not greater than 20 linear feet (6.1 linear meters) of linear *luminaires*, the total wattage of the *alteration* shall be no greater than the maximum *LPA* permitted by Table 9.4.2-2, or the total new wattage shall be at least 50% below the total original wattage of that *lighting system*. Additionally, the new and retrofitted lighting shall comply with the control requirements of Section 9.4.1.4(a).

**9.1.4 Interior and Exterior Wattage**

f. The wattage of a retrofitted *luminaire* shall be the *manufacturer’s* *labeled* input power of the new *light source* plus *driver*.

~~f~~g. The wattage of all other miscellaneous lighting *equipment* shall be the specified wattage of the lighting *equipment*.

## Amendments to Daylighting Section 9.4.1.1

Amend Section 9.4.1.1 of ASHRAE 90.1-2019 as follows:

**Section 9.4.1.1**

[…]

1. *Automatic daylight responsive controls for sidelighting:*In any *space* where the combined input power of all *general lighting* completely or partially within the *primary sidelighted* areas is 75 ~~150~~ W or greater, the *general lighting* in the *primary sidelighted* areas shall be controlled by photocontrols.

In any *space* where the combined input power of all *general lighting* completely or partially within the *primary sidelighted area* and *secondary sidelighted area* is 150 ~~300~~ W or greater, the *general lighting* in the *primary sidelighted area* and *secondary sidelighted area* shall be controlled by photocontrols. *General lighting* in the *secondary sidelighted area* shall be controlled independently of the general lighting in the *primary sidelighted area*. […]

**Exception to 9.4.1.1(e)**

The following areas are exempted from Section 9.4.1.1(e):

1. *Primary sidelighted areas* where the top of any existing adjacent structure or natural object is at least twice as high above the windows as its horizontal distance away from the windows.

2. Sidelighted areas where the total glazing area is less than 20 ft2.

3. ~~Retail~~ *~~spaces.~~*

*~~4.~~ Primary sidelighted areas* adjacent to *vertical fenestration* that have external projections and no *vertical fenestration* above the external projection, where the external projection has a *projection factor* greater than 1.0 for *north-oriented* projections or where the external projection has a *projection factor* greater than 1.5 for all other orientations (see Figure 3.2-6).

1. *Automatic daylight responsive controls for toplighting:* In any *space* where the combined input power for all *general lighting* completely or partially within *daylight area under skylights* and *daylight area under roof monitors* is 75 ~~150~~ W or greater, *general lighting* in the *daylight area* shall be controlled by photocontrols. The *control system* shall have the following characteristics: […]

## Addition of New Section 9.4.4 Horticultural Lighting

* 1. **9.4.4 Horticultural lighting.**
  2. Luminaires in *indoor grow* spaces and *greenhouse* spaces used for *horticultural lighting* shall have a *photosynthetic photon efficacy* (PPE) of at least 2.1 μmol/J.

## Amendments to Verification, Testing, and Commissioning

Amend Section 9.9 of ASHRAE 90.1-2019 as follows:

**9.9 Verification, Testing, and Commissioning**

**9.9.1 Verification and Testing**

Lighting *control devices* and control *systems* shall be tested in accordance with this section and Section 4.2.5.1 to verify that *control* hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the *construction documents* and *manufacturer’*s installation instructions. When *occupancy sensors*, time switches, programmable schedule controls, or *photosensors* are installed, at a minimum, the following procedures shall be performed:

…

Verification and *~~FTP~~FPT* documentation shall comply with Section 4.2.5.1.2.

**9.9.2 Commissioning**

The *energy* performance of the *lighting systems* shall be *commissioned* in accordance with Section 4.2.5.2, and reporting shall comply with Section 4.2.5.2.2.

## Amendments to Section 10.1

Amend Section 10.1 of ASHRAE 90.1-2019 as follows

**10.1 General**

**10.1.1 Scope**

This section applies ~~only~~ to other *equipment* asdescribed ~~below~~ in Section 10.4.

**~~10.1.1.1~~ 10.1.2 New Buildings**

Other *equipment* installed in new *buildings* shall comply with the requirements of ~~this~~ Section 10.2.

**~~10.1.1.2~~ 10.1.3 Additions to Existing Buildings**

Other *equipment* installed in additions to *existing buildings* shall comply with the requirements of ~~this~~ Section 10.2 .

**~~10.1.1.3~~ 10.1.4 Alterations to ~~Existing Buildings~~ Building service equipment**

*Alterations* to other *building service equipment* or *systems* shall comply with the requirements of t ~~this~~ Section 10.2 as applicable to those specific portions of the *building* and its *systems* that are being altered.

**~~10.1.1.3.1~~ 10.1.4.1**

Any new *equipment* subject to the requirements of ~~this~~ Section 10 that is installed in conjunction with the *alterations* as a direct replacement of *existing equipment* or *control devices* shall comply with the specific requirements applicable to that *equipment* or *control devices*.

Exception to ~~10.1.1.3.1~~ 10.1.4.1

Compliance shall not be required for the relocation or reuse of *existing equipment*.

**10.1.5 Climate**

Climate zones shall be determined in accordance with Section 5.1.5.

## Amendments to Section 10.2

Amend Section 10.2 and delete Section 10.4.5 of ASHRAE 90.1-2019 as follows:

**10.2.1** **Compliance**

Compliance with Section 10 shall be achieved by meeting all requirements of Section 10.1, “General”; Section 10.4, “Mandatory Provisions”; Section 10.5 "~~Prescriptive Path~~ Clean Energy" and Section 10.8, “Product Information.”

**10.2.2**

Projects using the ~~Energy Cost Budget Method (Section 11 of this standard)~~ Appendix G must comply with Section 10.4, “Mandatory Provisions” ~~the mandatory provisions of this section~~, and 10.5 “Clean Energy,” as a portion of that compliance path.

**…**

## Deletion of Section 10.4.5

**10.4.5 *Reserved***

~~Air curtain units performance shall be tested in accordance with ANSI/AMCA 220 or ISO 27327-1 and installed and commissioned in accordance with the manufacturer’s instructions to ensure proper operation and shall have a jet velocity speed of not less than 6.6 ft/s (2.0 m/s) at 6.0 in. (15 cm) above the floor and direction not less than 20 degrees towards the opening. Automatic controls shall be provided that will operate the air curtain unit with the opening and closing of the door~~

## Amendments to Section 10.4.6. Whole Building Energy Monitoring

Amend Section 10.4.6.2 of ASHRAE 90.1-2019 as follows:

[…]

**10.4.6.2 Recording and Reporting**

[…]

**Exceptions to 10.4.6.1 and 10.4.6.2**

1. *Buildings* or additions less than ~~25,000~~ 10,000 ft2.

2. Individual tenant spaces less than ~~10,000~~ 5,000 ft2.

[…]

## Addition of new Section 10.4.8 Compressed Air Systems

Add Section 10.4.6 of ASHRAE 90.1-2019 as follows:

**~~10.4.6~~ 10.4.8 Compressed Air *Systems***

All compressed air *systems* in factory industrial occupancies shall meet the requirements of Subsections ~~10.4.6.1~~ 10.4.8.1 through ~~10.4.6.5~~ 10.4.8.5. These requirements apply to the compressors, related *piping* *systems*, and *controls* that provide compressed air. This section does not apply to any *equipment* or *controls* that use or process the compressed air.

**EXCEPTION to Section ~~10.4.6~~ 10.4.8**: Medical air *systems*.

**~~10.4.6.1~~ 10.4.8.1 Part Load Controls and Efficiency.** Compressed air *systems* where the total motor power is 25 hp (18 kW) or more shall be equipped with appropriately sized *trim compressor(s)* and primary storage. The compressed air *system* shall comply with either A or B:

* 1. The compressed air *system* shall include one or more variable speed drive (VSD) compressors. For *systems* with more than one compressor, the total combined capacity of the VSD compressor(s) acting as *trim compressors* must be at least 1.25 times the largest net capacity increment between combinations of compressors. The compressed air *system* shall include primary storage of at least three gallons per actual cubic feet per minute (acfm) (8 litres per L/s) of the largest trim compressor; or,
  2. The total effective trim capacity of a compressor system is the size of the continuous operational range where the specific power of the compressor(s) (kW/100 acfm) (kW/50 L/s) is within 15% of the specific power at their most efficient operating point. The total effective trim capacity of the system is the sum of the effective trim capacity of the trim compressors.

Systems shall include primary storage of at least four gallons per acfm (8 litres per L/s) of the largest trim compressor and meet 1 or 2:

1. S*ystems* with more than one compressor, not including backup compressors, shall include a compressor or set of compressors with total effective trim capacity at least the size of the largest net capacity increment between combinations of compressors, or the size of the smallest compressor, whichever is larger.
2. For s*ystems* with one compressor, not including backup compressors, the total effective *trim capacity* shall include the range from 70% to 100% of rated capacity.

**EXCEPTIONS to Section ~~10.4.6.1~~ 10.4.8.1:**

1. *Alterations* where the total combined added or replaced compressor motor power is less than the average per-compressor power of all compressors in the *system*.
2. *Alterations* where all added or replaced compressors are variable-speed drive (VSD) compressors and the compressed air *system* includes primary storage of at least three gallons per actual cubic feet per minute (acfm) (8 litres per L/s) of the largest trim compressor.
3. Compressed air *systems* that have been approved by the *Authority Having Jurisdiction* as having demonstrated that the *system* serves loads for which typical air demand fluctuates less than 10%.
4. *Alterations* of existing compressed air *systems* that include one or more centrifugal compressors.

**~~10.4.6.2~~ 10.4.8.2 Controls.** Compressed air *systems* with three or more compressors, including backup compressors, with a combined input power of more than 150 hp (112 *kW*) shall operate with controls that are able to choose the most energy efficient combination and loading of compressors in the *system* based on the current compressed air demand.

**~~10.4.6.3~~ 10.4.8.3 Monitoring.** Compressed air *systems* having a combined input power rating equal to or greater than 150 hp (112 *kW*) shall have an energy and air demand monitoring *system* with the following minimum requirements:

A. Measurement of *system* pressure.

B. Measurement or calculation of current or power of each compressor.

C. Measurement or determination of total airflow from all compressors in acfm (L/s or m3/h).

D. Data logging of pressure, power in *kW*, airflow in acfm (L/s or m3/h)., and compressed air *system* specific power in *kW*/100 acfm (*kW*/50 L/s) at intervals of 5 minutes or less.

E. The *equipment* shall be configured to record not less than six months of data and shall be capable of exporting the data.

F. Visual trending display of each recorded point, load, and specific power.

**~~10.4.6.4~~ 10.4.8.4 Leak Testing of Compressed Air *Piping*.** Compressed air *system* *piping* shall be pressure tested after being isolated from the compressed air supply, storage tanks, and end uses. The *piping* shall be pressurized to the design operating pressure and the pressure allowed to stabilize. Test pressures shall be held for no less than 30 minutes, with no loss of pressure greater than 1.0%.

For *piping* less than or equal to 50 adjoining feet (16m) in length connections shall optionally be tested with a noncorrosive leak-detecting fluid or other leak detecting methods at the discretion of the *Authority Having Jurisdiction*.

**~~10.4.6.5~~ 10.4.8.5 Pipe Sizing.** For new *systems* and *additions* to *systems* with operating pressures above 50 psig (350 kPa (gage)), compressed air *piping* greater than 50 adjoining feet (16m) in length shall be designed and installed to minimize frictional losses in the distribution network.

Service line *piping* that delivers compressed air from distribution *piping* to end uses shall have inner diameters greater than or equal to 1 in.

Added or replaced *piping* in existing *systems* shall meet the requirements of A, below. New *systems* shall meet the requirements of either A or B.

1. ***Piping* section average velocity.** Compressor room interconnection and main header *piping* shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 20 ft/s (6 m/s). Compressor room interconnection and main header *piping* are the pipes that deliver compressed air from the compressor outlets to the inlet to the distribution *piping*. Each segment of distribution and service *piping* shall be sized so that at coincident peak flow conditions, the average velocity in the segment of pipe is no greater than 30 ft/s (9 m/s). Distribution *piping* is pipes that deliver compressed air from the compressor room interconnection *piping* or main header *piping* to the service line *piping*.
2. ***Piping* total pressure drop*.*** *Piping* shall be designed such that *piping* frictional pressure loss at coincident peak loads are less than 5% of operating pressure between the compressor and connection at point of use, prior to any end use regulators.

## Addition of new Section 10.5 Clean Energy

Add new section 10.5 to ASHRAE 90.1-2019 to read as follows:

**10.5 ~~Prescriptive Compliance Path (Not Used)~~ Clean Energy**

**10.5.1 Electrical Readiness**

***Reserved***

**10.5.2 Renewable Energy Systems**

Buildings shall comply with 10.5.2.1 through 10.5.2.3.

**10.5.2.1 On-site renewable energy systems.**

*Buildings* shall comply with one of the following:

1. *Buildings* shall have equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than 0.75 W/ft2 (8.1 W/m2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

2. *Buildings or building sites* complying with C405.15.1 shall be permitted to have equipment for on-site renewable energy generation with a direct current (DC) nameplate power rating of not less than 0.50 W/ft2 (6.0 W.m2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Direct-current-to-alternating-current inverters serving on-site renewable energy systems or on-site electrical energy storage systems shall be compliant with IEEE 1547-2018a and UL 1741-2021.

**Exception to 10.5.2.1:** The following buildings or building sites shall comply with Section 10.5.2.2:

1. A *building site* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft2 - day (3.5 kWh/m2 - day).
2. A*building*where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any *building* where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A building with gross conditioned floor area less than 5,000 square feet (465 m2).

**10.5.2.2 Off-site renewable energy.** *Buildings* that qualify for one or more of the exceptions to Section 405.14.1 and do not meet the requirements of Section 405.14.1 either in part or in full, with an on-site renewable energy system, shall procure off-site renewable electrical energy, in accordance with 10.5.2.2.1 and 10.5.2.2.2, that shall not be less than the total off-site renewable electrical energy determined in accordance with Equation 4-12.

(Equation 4-12)

TREoff = (RENoff \* 0.75 W/ft2 \* FLRA - IREon) \*15

where:

TREoff = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with Table 10.5.2.2

RENoff = Annual off-site renewable electrical energy from Table 10.5.2.2, in units of kilowatt-hours per watt of array capacity

FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors

IREon = Annual*on-site* renewable electrical energy generation of a new *on-site renewable energy system,* to be installed as part of the*building*project, whose rated capacity is less than the rated capacity required in Section 10.5.2.1

**10.5.2.2.1 Off-site procurement.**

The building owner as defined in the International Building Code shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-12, with one or more of the following:

|  |  |
| --- | --- |
| 1. | *A physical renewable energy power purchase agreement* |
| 2. | *A financial renewable energy power purchase agreement* |
| 3. | *A community renewable energy facility* |
| 4. | Off-site renewable energy system owned by the building property owner |

**10.5.2.2.2 Off-site contract.**

The renewable energy shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable electrical energy shall be procured in equal installments over the duration of the off-site contract.

**10.5.2.3 Renewable energy certificate documentation.**

The property owner or owner's authorized agent shall demonstrate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections 10.5.2.1 and 10.5.2.2 all of the following criteria for RECs and EACs shall be met:

|  |  |
| --- | --- |
| 1. | Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in 10.5.2.2.2 whichever is less; |
| 2. | Are created within a 12-month period of the use of the REC; and |
| 3. | Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy. |

**10.5.3 Electrical energy storage system.**

Buildings shall comply with 10.5.3.1 or 10.5.3.2.

**10.5.3.1 Electrical energy storage energy capacity.**

Each building shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

|  |  |
| --- | --- |
| 1. | ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kWDC) |
| 2. | ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kWDC) |

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

**10.5.3.2 Electrical energy storage system ready.**

Each building shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

|  |  |
| --- | --- |
| 1. | Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three largest stories (ft2) x 0.0008 kWh/ft2 |
| 2. | Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft2) x 0.0002 kWh/ft2 |

**10.5.3.2.1 ESS-ready location.**

Each ESS-ready area shall be located in accordance with Section 1207 of the*International Fire Code*.

**10.5.3.2.2 ESS-ready minimum area requirements.**

Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the*International Fire Code* and the UL9540 or UL9540A designated rating of the planned system. Where rated to UL9540A, the area shall be in accordance with the manufacturer's instructions.

**10.5.3.2.3 Electrical distribution equipment.**

The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the criteria of Section 10.5.3.2.

**10.5.4 Electric Vehicle Power Transfer Infrastructure.**

New parking facilities shall be provided with *electric vehicle*power transfer infrastructure in compliance with Sections 10.5.4.1 through 10.5.4.6.

**10.5.4.1 Quantity.**

The number of required *EV spaces, EV capable spaces*and*EV ready spaces*shall be determined in accordance with this Section and Table 10.5.4.1 based on the total number of*automobile parking spaces*and shall be rounded up to the nearest whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required automobile parking spaces required to have EV power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.
4. Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV capable spaces.
5. Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table 10.5.4.1 shall be used.

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

**Table 10.5.4.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE**

|  |  |  |  |
| --- | --- | --- | --- |
| OCCUPANCY | EVSE SPACES | EV READY SPACES | EV CAPABLE SPACES |
| GROUP A | 10% | 0% | 10% |
| GROUP B | 15% | 0% | 30% |
| GROUP E | 2% | 0% | 5% |
| GROUP F | 2% | 0% | 5% |
| GROUP H | 1% | 0% | 0% |
| GROUP I | 2% | 0% | 5% |
| GROUP M | 10% | 0% | 10% |
| GROUP R-1 | 20% | 5% | 75% |
| GROUP R-2 | 20% | 5% | 75% |
| GROUP R-3 AND R-4 | 2% | 0% | 5% |
| GROUP S exclusive of parking garages | 1% | 0% | 0% |
| GROUP S-2 parking garages | 1% | 0% | 0% |

**10.5.4.2 EV Capable Spaces.**

Each EV capable space used to meet the requirements of Section 10.5.4.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with 10.5.4.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.

**10.5.4.3 EV Ready Spaces.**

Each branch circuit serving EV ready spaces used to meet the requirements of Section 10.5.4.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum circuit capacity in accordance with C405.13.5.
3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

**10.5.4.4 EVSE Spaces.**

An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section 10.5.4.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with 10.5.4.5.
2. Have a minimum charging rate in accordance with 10.5.4.4.1.
3. Be located within 3 feet (914 mm) of each EVSE space it serves.
4. Be installed in accordance with Section 10.5.4.6.

**10.5.4.4.1 EVSE Minimum Charging Rate.**

1. Each installed EVSE shall comply with one of the following:
2. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
3. When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously charging each EVSE space at a minimum rate of no less than 3.3 kVA.
4. When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with 10.5.4.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.

**10.5.4.5 Circuit Capacity.** The capacity of electrical infrastructure serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each EV ready space or EVSE space it serves.
2. The requirements of 10.5.4.5.1

**10.5.4.5.1 Circuit Capacity Management**. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces, or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.
3. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

**10.5.4.6 EVSE Installation**. EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with International Building Code Section 1107.

**10.5.5 Grid Integration.**

***Reserved***

## Amendments to Verification, Testing, and Commissioning Clarification

Amend Section 10.9 of ASHRAE 90.1-2019 as follows:

~~10.5.1.1 On-Site Renewable Energy.~~

~~The building site shall have equipment for~~ *~~on-site renewable energy~~* ~~with a rated capacity of not less than 0.25 W/ft² or 0.85 Btu/ft~~~~2~~ ~~(2.7W/m~~~~2~~~~) multiplied by the sum of the~~ *~~gross conditioned floor area~~* ~~for all floors up to the three (3) largest floors.~~

~~Exceptions to 10.5.1.1:~~

~~…~~

1. ~~New construction or~~ *~~additions~~* ~~in which the sum of the~~ *~~gross conditioned floor area~~* ~~of the three largest floors of the new construction or~~ *~~addition~~* ~~is less than 10,000 ft2 (1000 m2).~~
2. *~~Alterations~~* ~~that do not include~~ *~~additions~~*~~.~~

**10.9 Verification, Testing, and Commissioning**

**10.9.1 Verification and Testing**

Other applicable *equipment* ~~Service water pressure-booster~~ *~~system~~* ~~controls, elevator standby mode and whole-building~~ *~~energy~~* ~~monitoring~~ shall be *~~commissioned~~* ~~or~~ verified and tested in accordance with this section and Section 4.2.5.1. Testing shall ~~to~~ verify that *control* elements and monitoring *systems* are configured and operating in accordance with ~~Sections~~ the applicable requirements of:

a. Service water pressure-booster *system* controls 10.4.2,

b. elevator standby mode 10.4.3.3,

c. air curtains 10.4.5~~, and 4.2.5.2~~.

d. whole building energy monitoring 10.4.6

e. pumps 10.4.7

f. Verification and *FPT* documentation shall comply with Section 4.2.5.1.1~~2~~.

**10.9.2 Commissioning**

The *energy* performance of the other *equipment* systems shall be *commissioned* in accordance with Section 4.2.5.2 and reporting shall comply with Section 4.2.5.2.2.

## Delete and Replace Section 11 (under development)

:

**ADDITIONAL EFFICIENCY REQUIREMENTS**

**11.1 Compliance**

New buildings shall comply with the requirements of Section 11.1.1. and core and shell buildings shall comply with 11.1.1.1.

**Note to reviewers:** The additional efficiency requirements for Part 1 are being revised pending additional energy modeling. When the C406 language in NYStretch 2023 (Part 1) is finalized, it will be modified as appropriate and placed into Standard 90.1 - Section 11.

## Amendments to Section 12

Amend Section 12 of ASHRAE 90.1-2019 as follows:

|  |  |
| --- | --- |
| ANSI/ASHRAE Standard 51-2016 | Laboratory Methods Of Testing Fans For Certified Aerodynamic Performance Rating |
| ANSI/ASHRAE Standard 62.2-2019 | Ventilation and Acceptable Indoor Air Quality in Residential Buildings |

|  |  |
| --- | --- |
| ANSI/AMCA Standard 230-15 with errata | Laboratory Methods of Testing Air Circulating Fans for Rating and Certification |

|  |  |
| --- | --- |
| ASTM C835-06 (2013) el | Standard Test Method for Total Hemispherical Emittance of Surfaces up to 1400°C |
| ASTM C1371-15 | Standard Test Method for Determination of Emittance of Materials Near Room Temperature using Portable Emissometers. |
| ASTM C1549-16 | Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer |
| ASTM E408-13 | Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques |
|  |  |
| 10 CFR Part 430, App U | Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans |

## Amendments to Normative Appendix C

**C1 MINIMUM INFORMATION**

The following minimum information shall be specified for the *proposed design*.

**C1.1 At the Building Level**

The *floor* area, broken down by *space-conditioning categories* and *building* area type, shall be specified. Each *building* area type shall be chosen from Table 9.5.1.

**C1.2 At the Exterior and Semiexterior Surface Level**

The *building envelope* assembly type, gross area, *orientation*, tilt, and associated *space-conditioning category* and *building* area type shall be specified. The surface shall be designated as exterior or semiexterior. A semiexterior surface separating a *conditioned space* from a *semiheated space* shall be specified with two associated *space-conditioning categories*. A semiexterior surface separating a *conditioned space* from an *unconditioned space* shall be specified with an associated *space-conditioning category* and with an adjacency to an *unconditioned space*. Exterior surfaces with the same *building envelope* assembly type and associated *space-conditioning category* and *building* area type whose orientations differ by no more than 22.5 degrees and whose tilts differ by no more than 22.5 degrees are allowed to be described as a single surface.

**C1.2.1 For Roofs**

The *class of construction*, *opaque* area, *U-factor*, *HC*, and insulation position shall be specified. Where three-year-aged test data for the solar reflectance and three-year-aged thermal *emittance* of the exterior *roof* surface are available, the three-year-aged solar reflectanceand three-year-aged thermal *emittance* shall be specified.

**C1.2.2 For Above-Grade Walls**

The *class of construction*, *opaque* area, *U-factor*, *HC*, and insulation position shall be specified.

**C1.2.3 For Below-Grade Walls**

The *opaque* area, average depth to the bottom of the *wall*, *C-factor*, *HC*, and insulation position shall be specified.

**C1.2.4 For Floors**

The *class of construction*, *opaque* area, *U-factor*, *HC*, and insulation position shall be specified.

**C1.2.5 For Slab-on-Grade Floors**

The *class of construction*, perimeter length, *F-factor*, and *HC* shall be specified.

**C1.2.6 For Uninsulated Assemblies**

All insulated assemblies (e.g., projecting balconies, perimeter edges of intermediate *floor* slabs, concrete *floor* beams over parking garages, *roof* parapet) shall be separately modeled.

**C1.2.7 For Thermal Bridges**

*a. Clear field thermal bridges, linear thermal bridges and point thermal bridges* shall be individually identified as required in Section 5.4.1.1~~.1~~.

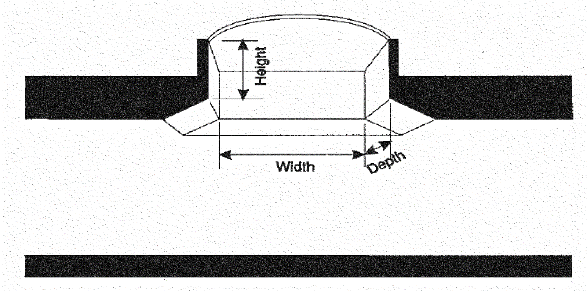
*b*. The *overall assembly U-factor* calculated in accordance with Section 5.4.1.1.2 and including the U-factors for all intersections described in Section 5.4.1.1.1.

**C1.3 For Opaque Doors**

The *class of construction*, area, and *U-factor* shall be specified. Each *opaque door* shall be associated with a surface as described in Section C1.2 and shall have the *orientation* of that surface.

**C1.4 For Fenestration**

The *class of construction*, area, assembly *U-factor*, assembly *SHGC*, *VT*, and *PF* shall be specified for *fenestration*. Each *fenestration* element shall be associated with a surface as defined in Section C1.2 and shall have the *orientation* of that surface.



**Figure C1.4   *Skylight well* dimensions.**

**C2 OUTPUT REQUIREMENTS**

**C2.1**

Name and contact information of the entity executing the simulation, and date of report.

**C2.2**

Location of the *building*, including street address and climate zone.

**C2.3**

Location corresponding to the weather data used to perform the simulation.

**C2.4**

*Simulation program* used to perform the simulation.

**C2.5**

Tables summarizing the minimum information described in Section C1.

**C2.6**

All differences between the proposed envelope performance factor and the base envelope performance factor.

**C2.7**

Peak heating and cooling loads for *building classes of constructions.*

**C2.8**

The version of the software and the link to the website that contains the ASHRAE Standard 140 results for the version used in accordance with Section C3.1.4.

**C3 SIMULATION GENERAL REQUIREMENTS**

**C3.1 Simulation Program**

The *simulation program* shall be a computer-based software program for the analysis of *energy* consumption in *buildings*. The *simulation program* shall include calculation methodologies for the *building* components being modeled.

***Informative Note:***

Examples of simulation programs include, but are not limited to, EnergyPlus and DOE-2.

**C3.1.1**

The *simulation program* shall be approved by the *adopting authority* and shall, at minimum, have the ability to explicitly model all of the following:

1. The base envelope performance factor, using only the input for the proposed envelope performance factor. The calculation procedure shall not allow the user to directly modify the building component characteristics of the base design.
2. 8760 hours per year.
3. Hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat *set points*, and HVAC system operation, defined separately for each day of the week and holidays.
4. Thermal mass effects.
5. The number of thermal zones in the proposed design or nine thermal zones, whichever is greater.
6. Air economizers with integrated control.
7. Continuous daylight dimming controls and photosensors.

**C3.1.2**

The simulation program shall have the ability to determine the proposed envelope performance factor and base envelope performance factor ~~by calculating annual energy costs~~.

***Informative Note:***

Neither the *proposed envelope performance factor* nor the *base envelope performance factor* are predictions of actual energy consumption ~~or costs~~ for the proposed design after construction. Actual experience will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, energy use not covered this procedure, HVAC and lighting system design differing from defaults prescribed in this section ~~changes in energy rates between design of the building and occupancy,~~ and the precision of the calculation tool.

**C3.1.3**

The *simulation program* shall be capable of performing design load calculations to determine required HVAC *equipment* capacities and airflow rates in accordance with Section 6.4.2 for both the *proposed design building envelope* and the *base design building envelope*.

**C3.1.4**

The *simulation program* shall be tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140. The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the simulation program alongside the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140, Annex A2, Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values or for missing results.

***Informative Note:***

There are no pass/fail criteria established by this requirement.

**C3.2 Climatic Data**

The *simulation program* shall perform the simulation using hourly values of climatic data, including temperature, humidity, solar radiation, and wind speed and direction from representative climatic data, for the *proposed design building envelope* location. For cities or urban regions for which several climatic data sources are available and for locations for which weather data are not available, the designer shall select available weather data that represent the climate at the *construction* site. Selected weather data shall be approved by the *authority having jurisdiction*.

**C3.2.1 Surface Exposure**

Semiexterior surfaces separating *conditioned spaces* from *unconditioned spaces* shall be simulated as exterior surfaces with no exposure to wind or solar radiation.

**~~C3.3 Purchased Energy Rates~~**

~~The following rates for purchased energy shall be used to determine the proposed envelope performance factor and the base envelope performance factor:~~

1. ~~Electricity: $0.1063/kWh~~
2. ~~Heating: $0.98/therm~~

**~~Exception to C3.3~~**

~~Where approved by the~~ *~~authority having jurisdiction~~*~~, actual annual rates for~~ *~~purchased energy~~* ~~or state average~~ *~~energy~~* ~~prices published by the Department of Energy’s Energy Information Administration shall be permitted. The same rates shall be used for both the~~ *~~proposed envelope performance factor~~* ~~and the~~ *~~base envelope performance factor~~*~~.~~

**C3.3 Compliance Calculations**

The proposed envelope performance factor and base envelope performance factor shall be calculated using the same

1. simulation program, and
2. climatic data~~, and~~
3. ~~purchased energy rates.~~

The proposed envelope performance factor and base envelope performance factor shall be expressed in units of *site energy*.

**C3.4 Calculation of Proposed Envelope Performance Factor**

The simulation model for calculating the *proposed envelope performance factor* shall be developed in accordance with Sections C3.5.1 through C3.5.11.

**C3.4.1 Space-Conditioning**

All *conditioned spaces* in the *proposed design* shall be simulated as being both heated and cooled, even if no cooling or heating *system* is being installed. Temperature *control set points* and schedules shall be consistent with those in the *building envelope trade-off schedules and loads* for the applicable *building* area type. All *semiheated spaces* shall be simulated as being heated and not cooled. The heating temperature *control set point* shall be 50°F for all hours.

**C3.4.2 Model Geometry and Thermal Zones**

The *building* model shall be divided into thermal zones described as follows:

1. Determine the ratio (*Rc*) of the *floor* area to the *gross wall area* for each unique combination of *space-conditioning category* and *building* area type. The index “c” refers to a combination of *space-conditioning category* and *building* area type as defined for each surface.
2. Create a perimeter zone for each unique combination of *building* area type, *above*-*grade*-*wall* *orientation*, and *space-conditioning category*. If there is more than one *above*-*grade*-*wall* assembly for a *building* area type and *orientation*, each *above*-*grade*-*wall* assembly shall be placed end-to-end in the order it is defined. The area of each perimeter zone shall be the *gross wall area* of the zone times *Rc* or 1.25, whichever is smaller.
3. For each unique combination of *space-conditioning category* and *building* area type with *Rc* greater than 1.25, interior zones shall be created and used in the trade-off procedure. The area of the interior zone shall be the total area for the unique combination of *space-conditioning category* and *building* area type less the area of the perimeter zones for that combination of *space-conditioning category* and *building* area type.
4. Create a below-*grade* zone for each unique combination of *space-conditioning category* and *building* area type associated with *below-grade walls*. If there is more than one *below*-*grade*-*wall* assembly for a *building* area type, each below-*grade*-*wall* assembly shall be placed end-to-end in the order it is defined. The area of each below-*grade* zone shall be the *gross wall area* of the zone times *Rc* or 1.25, whichever is smaller.
5. The *wall* height and the height of each thermal zone shall be 15 ft.
6. *Roof* area and *floor* area associated with each *building* area type shall be prorated among all zones of the corresponding *building* area type in proportion to the zone area of each zone. *Roof* area and *floor* area in each zone shall be centered in the horizontal plane of the zone with the same aspect ratio as the horizontal plane of the zone.
7. *Slab-on-grade floor* perimeter associated with each *building* area type shall be prorated among perimeter zones of the corresponding *building* area type in proportion to the area of each zone.
8. *Vertical fenestration area* shall be assigned to the associated surface as described in Section C1.4. *Vertical fenestration* shall be centered on the associated surface with the same aspect ratio as the associated surface. Windows with equivalent *U-factor*, *SHGC*, and *VT* that do not include fins may be combined into a single window on the associated surface.
9. *Skylight* area shall be assigned to the associated surface as described in Section C1.4, prorated among interior zones containing the *roof* area with which the *skylight* area is associated, in proportion to the associated *roof* area. If the total *skylight* area exceeds the associated *roof* area in interior zones, the remaining *skylight* area shall be prorated among perimeter zones containing the *roof* area with which the *skylight* area is associated, in proportion to the associated *roof* area.
10. Each zone shall be modeled as being fully enclosed. Zone boundaries not created as described above shall be modeled as adiabatic interior surfaces.

**C3.4.3 Daylight Area and Photosensor Location**

*Daylight areas* and *photosensors* shall not be modeled in *residential* zones. In each *nonresidential* zone, *daylight areas* and *photosensor* locations shall be modeled in accordance with the following:

* + - 1. For each *nonresidential* zone associated with *vertical fenestration*, the *daylight area* shall be modeled as directly adjacent to the *vertical fenestration* with a width equal to the width of the *vertical fenestration* and a depth equal to the head height of the *vertical fenestration*.
      2. In each *nonresidential* zone associated with *skylights*, the *daylight area under skylights* shall be modeled as bounded, in each direction, by the edge of the *skylight* area plus 10 ft or the distance to the edge of the zone, whichever is less.
      3. For each *daylight area* associated with *vertical fenestration*, a *photosensor* shall be modeled as located at the center of the width of the *daylight area*, at the depth of the *daylight area* and at a height of 3 ft.
      4. For each *daylight area* associated with a *skylight*, a *photosensor* shall be modeled as located at the center of the horizontal plane of the *skylight* and at a height of 5 ft.

**C3.4.4 Schedules**

The schedule types listed in Section C3.1.1(c) shall be required input. The schedules shall be consistent with those in the *building envelope trade-off schedules and loads*1 for the applicable *building* area type.

**C3.4.5 Building Envelope**

The *building envelope* shall reflect the information specified in Section C1.

**Exception to C3.4.5** Where three-year-aged test data for the solar reflectanceand three-year-aged thermal *emittance* of the exterior *roof* surface are unavailable, the exterior *roof* surface shall be modeled with a solar reflectanceof 0.30 and a thermal *emittance* of 0.90.

**C3.4.5.1 Shading**

Manually operated interior shades shall be modeled on all *vertical fenestration*. Shades shall be modeled to be in the lowered position when either the transmitted luminance is greater than 200 cd/ft2 or the direct solar transmitted *energy* exceeds 30 Btu/h·ft2 and then remain lowered for rest of the day. Shades shall be modeled with visible light transmittance of 0.10, visible light reflectanceof 0.40, solar transmittance of 0.21, and solar reflectanceof 0.23. Permanent shading devices such as fins and overhangs shall be modeled.

**C3.4.5.2 Dynamic Glazing**

*Automatically* controlled *dynamic glazing* is allowed to be modeled. Manually controlled *dynamic glazing* shall use the average of the minimum and maximum values for both *SHGC* and *VT*.

**C3.4.5.3 Air Leakage**

~~The~~ *~~air leakage~~* ~~rate of the~~ *~~building envelope~~* ~~(~~*~~I~~~~75Pa~~*~~) at a pressure differential of 75 Pa (0.3 in. of water) shall be 0.4 0.3 cfm/ft~~~~2~~ ~~of~~ *~~building envelope~~* ~~area when~~ *~~air leakage~~* ~~compliance is based on whole-building pressurization testing and shall be 0.45 cfm/ft~~~~2~~ ~~of~~*~~building envelope~~*~~area when~~ *~~air leakage~~* ~~compliance is based on verification.~~

The measured *air leakage* rate of the *building envelope* (*I75Pa*) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) shall be modeled.

The *air leakage* of the *building envelope* shall be converted to the appropriate units to describe the *air leakage* as a function of the area of *walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior as follows:

IAGW = 0.112 × I75Pa × S/AAGW

where

*I75Pa =* *air leakage* rate of the *building envelope* (cfm/ft2) at a fixed *building* pressure differential of 75 Pa (0.3 in. of water)

S = total area of the *building envelope* (ft2) including the lowest *floor*, any *below-grade walls* or *above-grade walls*, and *roof* (including *vertical fenestration* and *skylights*)

*IAGW =* adjusted *air leakage* rate of the *building envelope* (cfm/ft2) at a reference wind speed of 10 mph and relative to the area of the *above-grade walls*

*AAGW =* the total area of *above-grade walls* that comprise the *building envelope*, ft2

**Exception to C3.4.5.3**

If the *simulation program* cannot simulate air leakage as a function of the area of *walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior, the air leakage of the *building envelope* shall be converted to the appropriate units to describe the air leakage as a function of *gross floor area* as follows:

IFLR = 0.112 × I75Pa × S/AFLR

Where

*IFLR =* Adjusted air leakage rate of the *building envelope* (cfm/ft2) at a reference wind speed of 10 mph and relative to the *gross floor area*

*AFLR* = *gross floor area*, ft2

**C3.4.5.3.1 ~~Infiltration~~ *Air Leakage* Schedule**

To simulate *air leakage* as described in Section 5.4.3, infiltrationshall be adjusted in accordance with the infiltration schedule in the *building envelope trade-off schedules and loads* for the applicable *building* area type.

**C3.4.5.4 Thermal Bridges**

* + 1. *a.*The modeled *wall* assembly *U-factor* shall reflect the overall thermal transmittance include the effects of linear thermal bridges and point thermal bridges ~~be~~ determined based on Section 5.4.1.1.2.
    2. b. When the total area of penetrations from mechanical equipment listed in Tables 6.8.1-4 exceeds 1% of the *opaque above-grade wall* area, then mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5. Where mechanical equipment has been tested in accordance with testing standards approved by the *authority having jurisdiction*, the mechanical equipment penetration area may be calculated as a separate *wall assembly* with the *U-factor* as determined by such test.

**C3.4.6 Interior Surfaces**

Interior surfaces shall be modeled with visible light reflectances of 0.80 for ceilings, 0.50 for *walls*, for 0.20 for *floors*. Interior surfaces shall be modeled with a thermal *emittance* of 0.90.

**C3.4.7 Lighting**

The modeled lighting power shall be determined using the *lighting power density* allowances in Table 9.5.1 for the applicable *building* area type. The modeled lighting power shall be adjusted in accordance with the lighting schedule in the *building envelope trade-off schedules and loads* for the applicable *building* area type. Fifty percent (50%) of lighting in *daylight areas* shall be modeled with *continuous daylight dimming* *controls* such that when sufficient daylight is available at the corresponding *photosensor*, lighting power is reduced to maintain a minimum 50 fc for *conditioned spaces* and 30 fc for *semiheated spaces*. The minimum light output for the *continuous daylight dimming* shall be 6% of peak light output. Power input shall be modeled as 20% of lighting power at the minimum light output and scaled linearly to 100% of lighting power at peak light output.

**C3.4.8 HVAC Systems**

One *HVAC system* shall be provided for each thermal zone and shall have the following characteristics:

1. Constant-volume fan *control*.
2. Electrically-provided cooling with ~~EER from Table 6.8.1-12, based on requirements for~~ COPnfcooling=3.73 based on split system ~~air conditioners~~ heat pumps ~~with heating section type “all other”~~ cooling capacity between 65,000 Btu/h and 135.000 Btu/h. ~~The EER shall be adjusted to remove the fan power in accordance with Section 11.5.2c.~~
3. ~~Gas furnace with constant thermal~~ *~~efficiency~~* ~~equal to the minimum~~ *~~AFUE~~* ~~allowed for gas-fired warm-air furnaces with maximum capacity <225,000 Btu/h, in accordance with Table 6.8.1-5.~~ 3. Packaged electric air-source heat pump with the COPnfheating=3.66 ~~minimum allowed HSPF or COP from Table 6.8.1-2.~~modeled with electric auxiliary heat. The *system* shall be controlled with a multistage *space thermostat* and an *outdoor air thermostat* wired to energize auxiliary heat only on the last *thermostat* stage and when *outdoor air* temperature is less than 40°F.
4. The *ventilation* rate for each *building* area type shall be consistent with the *ventilation* rate in the *building envelope trade-off schedules and loads* for the applicable *building* area type.
5. *Air economizers*, except in Climate Zones 0 and 1. The high-limit shutoff shall be “Fixed Dry Bulb” type as described in Table 6.5.1.1.3.
6. *System* design supply air rates shall be based on a supply-air-to-room-air temperature difference of 20°F in cooling.
7. *~~System~~* ~~capacities used in the annual simulation shall be 1.5 times the capacities determined by the sizing simulations.~~
8. Fans shall ~~cycle ON~~ run continuously whenever the *space* ~~calls for heating or cooling~~ is occupied. The fan power shall be 0.3 W/cfm, and the fan *energy* shall be modeled explicitly.

**C3.4.9 Miscellaneous Loads**

Miscellaneous loads shall be modeled as included in the *building envelope trade-off schedules and loads* for the applicable *building* area type.

**C3.4.10 Occupant Density**

The occupant density shall be modeled according to the peak occupant density and the occupancy rate schedule in the *building envelope trade-off schedules and loads* for the applicable *building* area type.

**C3.4.11 Heat Gain from Occupants**

The sensible and latent heat gain due to occupants shall be modeled as included in the *building envelope trade-off schedules and loads* for the applicable *building* area type.

**C3.5 Calculation of Base Envelope Performance Factor**

The simulation model for calculating the *base envelope performance factor* shall modify the simulation model for calculating the *proposed envelope performance factor* as follows:

* 1. All *opaque* assemblies shall conform with assemblies detailed in Normative Appendix A and be modeled with the maximum *U-factor* required in ~~Section~~ ~~5.5.3~~ Table~~s~~ 5.5~~-4, 5.5-5, and 5.5-6~~, for the appropriate *~~class of construction,~~* *space-conditioning category*, climate zone and the following *class of construction*: *~~Mass walls~~* ~~and~~ *~~mass floors~~* ~~shall be modeled with~~ *~~HC~~* ~~equal to 7.2 Btu/ft~~~~2~~~~·°F. All other~~ *~~opaque~~* ~~assemblies shall be modeled with the same~~ *~~HC~~* ~~as the~~ *~~proposed design~~*~~.~~ *~~Mass walls~~* ~~shall be modeled with equal mass on each side of the insulation. All other~~ *~~opaque~~* ~~assemblies shall be modeled with insulation on the exterior.~~
* 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).
* *Opaque* *door* types shall be of the same type of *construction* as the *proposed design* and conform to the *U-factor* requirements from the same tables (A7).

1. The exterior *roof* surfaces shall be modeled with a solar reflectanceand thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as in the *proposed design*. The *above-grade wall* surfaces shall be modeled with a solar reflectance and thermal *emittance* as required in Section 5.5.3.2.2 and Section 5.5.3.2.2(a). All other *above-grade walls*, including those exempt from the requirements in Section 5.5.3.2.2 shall be modeled the same as the *proposed design*.
2. For *building* area types included in Table G3.1.1-1, *vertical fenestration areas* for new *buildings* and additions shall equal the percentage in Table G3.1.1-1 multiplied by the gross area of *above-grade walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior. Where a *building* has multiple *building* area types, each type shall use the values in the table. For *building* areas not shown in Table G3.1.1-1, *vertical fenestration areas* for new *buildings* and additions shall equal that in the *proposed design* or 40% of gross *above-grade wall* area, whichever is smaller.
3. The *vertical fenestration* shall be distributed on each face of the *building* in the same proportion as in the *proposed design*. If this would cause the combined *vertical fenestration* and *opaque door* area on a given face to exceed the *gross above-grade wall* area on that face, then the *vertical fenestration area* on the other faces shall be increased in proportion to the *gross above-grade wall* area of these faces such that the total baseline *building vertical fenestration* *area* is equal to that calculated following Table G3.1.1-1.
4. The *fenestration area* for an *existing building* shall equal the existing *fenestration area* prior to the proposed work and shall be distributed on each face of the *building* in the same proportions as the *existing building*.
5. *Fenestration* shall be assumed to be flush with the *wall* or *roof*. ~~If the~~ *~~fenestration~~**~~area~~* ~~for new~~ *~~buildings~~* ~~or~~ *~~additions~~* ~~exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met.~~ If the *fenestration area* facing west or east of the *proposed design* exceeds the area limit set in Section 5.5.4.5, 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 of the four simulations. *Fenestration U-factor* and *SHGC* shall be the maximum allowed for the appropriate *class of construction*, *space-conditioning category*, and climate zone in accordance with Section 5.5.4. ~~Where there is no~~ *~~SHGC~~* ~~requirement, the~~ *~~SHGC~~* ~~shall be equal to 0.40 for all~~ *~~vertical fenestration~~* ~~and 0.55 for~~ *~~skylights~~*~~.~~ The *VT* for *fenestration* in the base envelope design shall be equal to 1.10 times the *SHGC*.
6. Manually operated interior shades shall be modeled on all *vertical fenestration* as described in Section C3.5.5.1. Permanent shading devices, such as fins and overhangs, shall not be modeled.
7. *Daylight areas* and *photosensor* locations shall be modeled as described in Section C3.5.3 after reducing the *fenestration area* as described in Section C3.6(c).
8. The *air leakage* rate of the *building envelope* (*I75Pa*) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) shall be 0.~~30~~ 0.15 cfm/ft2 of *building envelope area* for new construction and shall be 0.40 cfm.ft2 of *building envelope area* for *existing buildings*. ~~and~~ The *air leakage* rate of the *building envelope* shall be converted to units for the energy model using the same method as the *proposed envelope performance factor*.

## Amendments to Normative Appendix E

Amend Appendix E of ASHRAE 90.1-2019 as follows:

|  |  |  |
| --- | --- | --- |
| **Subsection No.**  6.5.3.8 | **Reference**  ASHRAE Guideline 36-2021 | **Title/Source**  High-Performance Sequences of Operation for HVAC Systems |

## Amendments to Normative Appendix F

Amend Appendix F of ASHRAE 90.1-2019 as follows:

**Table F-6 Ceiling Fan *Efficiency* Requirements for U.S. Applications (see 10 CFR 430)**

|  |  |  |  |
| --- | --- | --- | --- |
| *Equipment* Type | Size Category | Minimum *Efficiency* | Test Procedure |
| *Large diameter ceiling fan* | Blade span ≥84.5 in. (2.15m) | *CFEI* ≥ 1.00 at high (maximum) speed; and  *CFEI* ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed | 10 CFR 430 Appendix U |

## Amendments to Normative Appendix G

Amend Appendix G of ASHRAE 90.1-2019 as follows:

**PERFORMANCE RATING METHOD**

**G1 GENERAL**

**G1.1 Performance Rating Method Scope**

This appendix offers an alternative path for minimum standard compliance in accordance with Section 4.2.1.1 when administered by a *building official*. It is also provided for those who wish to use this appendix to quantify performance that exceeds the requirements of this standard when administered by a *rating authority* and not seeking minimum standard compliance in accordance with Section 4.2.1.1. It shall be used for evaluating the performance of all such *proposed designs*, including *alterations* and additions to *existing buildings*, except designs with no mechanical *systems*. In the case where this appendix is administered solely by a *building official* to determine compliance with this standard in accordance with Section 4.2.1.1, all references to “*rating authority*” shall be replaced with “*building official.*”

**G1.2 Performance Rating**

**G1.2.1 Mandatory Provisions**

The proposed *building* design shall comply with all of the following:

* + - 1. Sections 5.2.1, 6.2.1, 7.2.1, 8.2.1, 9.2.1, ~~and~~ 10.2.1, 10.5.3, 10.5.4, 10.9.
      2. ~~Sections C408 and Appendix CC (if mandated by local ordinance) of the 2021 IECC (as amended).~~
      3. Interior lighting power shall not exceed the *interior lighting power allowance* determined using either Building Area Method described in Section 9.5.1 or the Space-by-Space Method described in Section 9.5.2 by more than 10%.

1. ~~Table G3.7 and the methodology described in Section 9.6.1, or~~
2. ~~Table G3.8 and the methodology described in Section 9.5.1; and~~
3. For new *buildings*,one of the following is met:
4. The *building envelope* complies with Section 5.5, “Prescriptive Building Envelope Compliance Path”; or
5. Using Section 5.6, “Building Envelope Trade-Off Option”, the *proposed envelope performance factor* shall not exceed the *base envelope performance factor* by more than ~~15~~ TBD% in multifamily, hotel/motel, and dormitory *building* area types. For all other *building* area types, the limit shall be ~~7~~ TBD %. For buildings with both *residential* and *nonresidential* occupancies, the limit shall be based on the area weighted average of the *gross conditioned floor area*.

**Note to reviewers:** The TBD values will be established using the same methodology as for NYStretch 2020 and ASHRAE 90.1 2019 Addendum CR, except with the passing threshold set at the ~~WWR exceeding values in Table G3.1.1-1 by 20%~~ 50% WWR instead of a fixed 70% WWR with envelope otherwise minimally compliant with requirements in Section 5 as amended.

**G1.2.2 Performance Rating Calculation**

The performance of the *proposed design* is calculated in accordance with provisions of this appendix using the following formula:

Performance Site Energy ~~Cost~~ Index = *Proposed building performance/Baseline building performance*

Both the *proposed building performance* and the *baseline building performance* shall include all end-use load components within and associated with the *building* when calculating the Performance Site Energy ~~Cost~~ Index.

**Exception to G1.2.2**

Energy used to recharge or refuel vehicles that are used for off-building site transportation purposes shall not be modeled in the *baseline building performance* or the *proposed building performance*.

***Informative Note***

Neither the *proposed building performance* nor the *baseline building performance* are predictions of actual *energy* consumption ~~or costs~~ for the *proposed design* after *construction*. Actual experience will differ from these calculations due to variations such as occupancy, *building* operation and maintenance, weather, *energy* use not covered by this procedure, ~~changes in~~ *~~energy~~* ~~rates between design of the~~ *~~building~~* ~~and occupancy,~~ and the precision of the calculation tool.

**G1.3 Submittals**

**G1.3.1 General**

Compliance documentation and supplemental information shall be submitted in accordance with Section 4.2.2 of this standard.

**G1.3.2 Application Documentation**

~~Simulated performance shall be and documentation shall be submitted to the rating authority. The information shall be submitted in a report and shall include the following:~~ The following documentation shall be submitted to the *rating authority* using the forms developed by the U.S. Department of Energy available at energycodes.gov/ashraestandard-901-performance-based-compliance-form.

* + - * 1. ~~A brief description of the project, the key energy efficiency improvements compared with the requirements in Sections 5 through 10, t~~ The simulation program used, the version of the simulation program, and the results of the energy analysis including the calculated values for the baseline building unregulated energy (BBUE), baseline building regulated energy (BBRE), Building Performance Factor (BPF), *baseline building performance*, the *proposed building performance*, Performance Site Energy Index (PSEI), and Performance Site Energy Index Target (PSEIt). ~~This summary shall contain the calculated values for the baseline building performance, the proposed building performance, and the percentage improvement.~~
        2. An overview of the project that includes the number of stories (above and below *grade*), the typical *floor* size, the uses in the *building* (e.g., office, cafeteria, retail, parking, etc.), the gross area of each use, and whether each use is *conditioned space*.
        3. A list of the *energy*-related features that are included in the design and on which the performance rating is based. This list shall document all *energy* features that differ between the models used in the *baseline building performance* and *proposed building performance* calculations.
        4. A list showing compliance for the *proposed design* with all the requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 (mandatory provisions).
        5. A list identifying those aspects of the *proposed design* that are less stringent than the requirements of 5.5, 6.5, 7.5, and 9.5, ~~and 9.6~~ (prescriptive provisions).
        6. A list identifying those aspects of the *proposed design* that are more stringent than the requirements of Sections 5 through 10.
        7. A table with a summary by end use of the ~~energy cost savings in the~~ *proposed building performance* and *baseline building performance*, with each end use separated into regulated and unregulated components.
        8. A site plan showing all adjacent *buildings* and topography that may shade the proposed *building* (with estimated height or number of stories).
        9. *Building* elevations and *floor* plans ~~(schematic is acceptable)~~.
        10. A diagram showing the *thermal blocks* used in the computer simulation.
        11. An explanation of any significant modeling assumptions.
        12. Backup calculations and material to support data inputs (e.g., *U-factors* for *building envelope* assemblies, NFRC ratings for *fenestration*, end-uses identified in Table G3.1, “1. Design Model,” paragraph [a]).
        13. ~~Input and output~~ ~~r~~Reports from the *simulation program* ~~or compliance software, including~~ showing:
        14. a breakdown of *energy* use by at least the following components: lights, internal *equipment* loads, *service water-heating* *equipment*, *space*-heating *equipment*, *space*-cooling and heat rejection *equipment*, fans, and other HVAC *equipment* (such as pumps).
        15. ~~The output reports shall also show~~ the amount of *unmet load hours* for both the *proposed design* and *baseline building design*.
        16. Description of energy-related features of the *baseline building design* and the *proposed design* to support requirements of Section G1.3.2(c).

*~~Purchased energy rates~~* ~~used in the simulations.~~

1. An explanation of any error messages noted in the *simulation program* output.
2. For any exceptional calculation methods employed, document the predicted *energy* savings by *energy* type, the *energy* cost savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.
3. The reduction in proposed building performance associated with on-site renewable energy.
4. The version of the software and the link to the website that contains the ASHRAE Standard 140 results for the version used in accordance with Section G2.2.4.
5. Simulation input files for the *budget building design* and the *proposed design* shall be made available if requested by the *rating authority*.

**G1.3.3 Completion Requirements**

Completion requirements shall be in compliance with Section 5.7.3, 6.7.3, 7.7.3, 8.7.3, 9.7.3, and 10.7.3.

**G2 SIMULATION GENERAL REQUIREMENTS**

**G2.1 Performance Calculations**

The proposed building performance and baseline building performance shall be calculated using the following:

1. The same simulation program.
2. The same weather data.
3. ~~The same energy rates.~~

**G2.2 Simulation Program**

The *simulation program* shall be a computer-based program for the analysis of *energy* consumption in *buildings* ~~(a program such as, but not limited to, DOE-2, BLAST, or EnergyPlus). The~~ *~~simulation program~~* ~~shall include calculation methodologies for the~~ *~~building~~* ~~components being modeled.~~ For components that cannot be modeled by the *simulation program*, the exceptional calculation methods requirements in Section G2.5 shall be used.

**Exception:**

When approved by the *adopting authority*, a separate computer-based program shall be permitted to be used to calculate *on-site renewable energy*.

***Informative Note:***

For the ease of use and consistent application, the *simulation program* should automatically implement the requirements of this appendix to generate the baseline design and *proposed design* models based on the user model of the *proposed design*.

**G2.2.1**

The *simulation program* shall be approved by the *rating authority* and shall, at a minimum, have the ability to explicitly model all of the following:

1. 8760 hours per year.
2. Hourly variations in occupancy, lighting power, miscellaneous *equipment* power, *thermostat* *set points*, and *HVAC system* operation, defined separately for each day of the week and holidays.
3. Thermal mass effects.
4. Ten or more thermal zones.
5. Part-load performance curves for mechanical *equipment.*
6. Capacity and efficiency correction curves for mechanical heating and mechanical cooling equipment.
7. Air economizers with integrated control.
8. *Baseline building design* characteristics specified in Section G3.

**G2.2.2**

The *simulation program* shall have the ability to either directly determine the *proposed building performance* and *baseline building performance* or produce hourly reports of *energy* use by an *energy* source suitable for determining the *proposed building performance* and *baseline building performance* using a separate calculation ~~engine~~.

**G2.2.3**

The *simulation program* shall be capable of performing design load calculations to determine required HVAC *equipment* capacities and air and water flow rates in accordance ~~with generally accepted engineering standards and handbooks (for example, ASHRAE Handbook of Fundamentals)~~ Section 6.4.2.1 for both the *proposed design* and *baseline building design*.

**G2.2.4**

The *simulation program* shall be tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140. The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the simulation program alongside the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values or for missing results.

***Informative Note***

There are no pass/fail criteria established by this requirement.

**G2.3 Climatic Data**

The *simulation program* shall perform the simulation using hourly values of climatic data, ~~such as~~ including temperature, ~~and~~ humidity, solar radiation, and wind speed and direction from representative climatic data, for the site in which the *proposed design* is to be located. ~~For cities or urban regions with several climatic data entries~~ For locations for which several climatic data sources are available or ~~and for locations where~~ weather data ~~are~~ is not available, the designer shall select available weather data that best represent the climate at the *construction* site. The selected weather data shall be approved by the *rating authority*.

**G2.4 Renewable, Recovered, and Purchased Energy**

**~~G2.4.1 On-Site Renewable Energy and Site-Recovery Energy~~**

**~~G2.4.1.1~~ G2.4.1 Proposed Building Design**

**G2.4.1.1** ***Site-recovered energy***

*Site-recovered energy* shall not be considered *purchased energy* and shall be subtracted from the *proposed design* *energy* consumption prior to calculating the *proposed building performance*.

**G2.4.1.2** *On-site renewable energy*

*On-site renewable energy* shall be subtracted from the *proposed design* *energy* consumption prior to calculating the *proposed building performance* provided that the *building* owner either:

1. owns the on-site renewable energy system or
2. has signed a lease agreement for the on-site renewable energy system for at least 15 years or
3. has signed a contractual agreement to purchase energy generated by the on-site renewable energy system for at least 15 years.

**G2.4.1.3**.  ***Off-site renewable energy***

Eighty five percent of annual o*ff-site renewable energy* procured in accordance with *Sections 10.5.2.2.2 and 10.5.2.2.3* shall be subtracted from the *proposed design* *energy* consumption prior to calculating the *proposed building performance*

**G2.4.1.4 Purchased hot water, steam and chilled water**

If approved by the *rating authority*, the actual performance of the *systems* providing purchase hot water, steam or chilled water may be used for determining *proposed building performance* but not for determining the PBPnre as defined in Section 4.2.1.1. The actual performance of such *systems* shall include efficiency of the heating or cooling plant, auxiliary equipment and distribution losses associated with delivery of steam, hot water or chilled water to the building.

**G2.4.~~1.~~2 Baseline Building Design**

**~~Annual Energy Costs~~**

~~The~~ *~~design energy cost~~* ~~and baseline~~ *~~energy~~* ~~cost shall be determined using either actual rates for~~ *~~purchased energy~~* ~~or state average~~ *~~energy~~* ~~prices published by DOE’s Energy Information Administration (EIA) for commercial~~ *~~building~~* ~~customers, but rates from different sources may not be mixed in the same project.~~

Where *on-site renewable energy* or *site-recovered energy* is used, the *baseline building design* shall be based on the *energy* source used as the backup *energy* source, or the baseline *system* *energy* source in that category if no backup *energy* source has been specified, except where the baseline energy source is prescribed in Tables G3.1.1-2 and G3.1.1-3. Where the proposed design includes *on-site electricity generation systems* other than *on-site renewable energy systems*, the baseline design shall include the same generation systems excluding its *site-recovered energy*.

**G2.4.3 Prescriptive *Renewable Energy* in the *Proposed Design***

For the purpose of determining PBPpre in Section 4.2.1.1, the prescriptive *renewable energy* *system* in the *proposed design* shall be modeled as follows

a. Where a system providing *on-site renewable energy* has been modeled in the *proposed design*, the same *system* shall be modeled identically in the *baseline building design*, except the rated capacity shall meet the requirements of Section 10.5.1.1. Where more than one type of on-site renewable energy system is modeled, the total capacities shall be allocated in the same proportion as in the *proposed design*.

b. Where no *system* exists or is specified to provide *on-site renewable energy* in the proposed design, *on-site renewable energy* shall be modeled as an unshaded photovoltaic system with the following physical characteristics:

• Size: Rated capacity per Section 10.5.1.1

• Module Type: Crystalline silicon panel with a glass cover, 19.1% nominal efficiency and temperature coefficient of –0.47%/°C; performance shall be based on a reference temperature of 77°F and irradiance of 317 Btu/ft2·h.

• Array Type: Rack-mounted array with installed nominal operating cell temperature (INOCT) of 103°F

• Total system losses (DC output to AC output): 11.3%

• Tilt: 0-degrees (mounted horizontally)

• Azimuth:180 degrees

If the on-site renewable energy system cannot be modeled in the simulation program, Section G2.5 shall be used.

***~~Informative Note~~***

~~The above provision allows users to gain credit for features that yield load management benefits. Where such features are not present, users can simply use state average unit prices from EIA, which are updated annually and readily available on EIA’s web site~~

**G2.5 Exceptional Calculation Methods**

When the *simulation program* does not model a design, material, or device of the *proposed design*, an exceptional calculation method shall be used as approved by the *rating authority*. Where there are multiple designs, materials, or devices that the *simulation program* does not model, each shall be calculated separately, and exceptional savings determined for each. At no time shall the total exceptional savings constitute more than half of the difference between the *baseline building performance* and the *proposed building performance*. All applications for approval of an exceptional method shall include the following:

* + - 1. Theoretical and empirical information verifying the method’s accuracy, and step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
      2. Copies of all spreadsheets used to perform the calculations.
      3. A sensitivity analysis of *energy* consumption when each of the input parameters that are estimated is varied from half to double the value assumed.
      4. The calculations shall be performed on a time-step basis consistent with the *simulation program* used.
      5. The ~~performance rating~~ Performance Cost Index calculated with and without the exceptional calculation method.

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| --- | --- | --- |
| **Table G3.1   Modeling Requirements for Calculating Proposed and *Baseline Building Performance*** | | |
| **No.** | **Proposed *Building* Performance** | ***Baseline Building* Performance** |
| 1. Design Model | | |
| a. The simulation model of the *proposed design* shall be consistent with the design documents, including proper accounting of *fenestration* and *opaque* *building envelope* types and areas; interior lighting power and *controls*; *HVAC system* types, sizes, and *controls*; and *service water-heating* *systems* and *controls*. All end-use load components within and associated with the *building* shall be modeled, including but not limited to exhaust fans, parking garage *ventilation* fans, snow-melt and freeze-protection *equipment*, facade lighting, swimming *pool* heaters and pumps, elevators and escalators, refrigeration, and cooking. Where the *simulation program* does not specifically model the functionality of the installed *system*, spreadsheets or other documentation of the assumptions shall be used to generate the power *demand* and operating schedule of the *systems*.  b. All *conditioned spaces* in the *proposed design* shall be simulated as being both heated and cooled even if no heating or cooling *system* is to be installed.  **Exception:**  *Spaces* designed with heating only *systems* serving storage rooms, stairwells, vestibules, electrical/mechanical rooms, and restrooms not exhausting or transferring air from mechanically cooled thermal zones in the *proposed design* shall not be modeled with *mechanical cooling*.  c. When the *performance rating method* is applied to *buildings* in which *energy*-related features have not yet been designed (e.g., a *lighting system*), those yet-to-be-designed features shall be modeled in the *proposed design* to comply with but not exceed the requirements of this Standard as described in Table G3.1 parts 6, 10, 11, and 12. Where the *space* classification for a *space* is not known, the *space* shall be categorized as an office *space*. | | The *baseline building design* shall be modeled with the same number of *floors* and identical *conditioned floor area* as the *proposed design*.  The *baseline building design* shall be developed by modifying the *proposed design* as described in Section G3. Except as specifically instructed, all *building* *systems* and *equipment* shall be modeled identically in the *proposed design* and *baseline building design*.  Where the *baseline building systems* and *equipment* are permitted to be different from the proposed design but are not prescribed in this appendix, the baseline must be determined based on the following, in the order of priority:  a. Requirements in Sections 5-10  b. Requirements of other efficiency or equipment codes or standards applicable to the design of the building systems and equipment. |
| 2. Additions and *Alterations* | | |
| It is acceptable to predict performance using *building* models that exclude parts of the *existing building*, provided that all of the following conditions are met:  a. Work to be performed in excluded parts of the *building* shall meet the requirements of Sections 5 through 10.  b. Excluded parts of the *building* are served by *HVAC systems* that are entirely separate from those serving parts of the *building* that are included in the *building* model.  c. Design *space* temperature and *HVAC system* operating *set points* and schedules on either side of the boundary between included and excluded parts of the *building* are essentially the same.  ~~d. If a declining block or similar utility rate is being used in the analysis, and the excluded and included parts of the~~ *~~building~~* ~~are on the same utility meter, the rate shall reflect the utility block or rate for the~~ *~~building~~* ~~plus the~~ *~~addition~~*~~.~~ | | If the proposed *design* excludes parts of the *existing building*, the *baseline building* *design* shall exclude them as well.  When modeled, unmodified *existing building* components shall follow the same rules as new and modified *building* components. |
| 3. *Space* Use Classification | | |
| The space use classification within each thermal block shall be determined using the *space* type lighting classifications in accordance with Section ~~9.6.1.~~ 9.5.2  **Exceptions:**  Where space types neither exist nor are designated in design documents, use type shall be specified in accordance with 9.5.1.  The user may simplify the placement of the various *space* types within the *building* model, provided that *building* total areas and orientation of glazed exterior walls for each *space* type are accurate. | | Same as proposed design. |
| 4. Schedule | | |
| Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous *equipment* power, *thermostat* *set points*, and *HVAC system* operation shall be used. The schedules shall be typical of the proposed *building* type as determined by the designer and approved by the *rating authority*.  **Temperature and Humidity Schedules.** Temperature and humidity *control* *set points* and schedules as well as *temperature control throttling range* shall be the same for *proposed design* and *baseline building design*.  **HVAC Fan Schedules.** Schedules for HVAC fans that provide *outdoor air* for *ventilation* shall run continuously whenever *spaces* are occupied and shall be cycled on and off to meet heating and cooling loads during unoccupied hours.  **Exceptions:**   1. Where no heating and/or cooling *system* is to be installed, and a heating or cooling *system* is being simulated only to meet the requirements described in this table, heating and/or cooling *system* fans shall not be simulated as running continuously during occupied hours but shall be cycled on and off to meet heating and cooling loads during all hours. 2. HVAC fans shall remain on during occupied and unoccupied hours in *spaces* that have health- and safety-mandated minimum *ventilation* requirements during unoccupied hours. 3. HVAC fans shall remain on during occupied and unoccupied hours in *systems* primarily serving *computer rooms*. 4. Dedicated outdoor air supply fans shall stay off during unoccupied hours. | | Same as proposed design.  **Exceptions**   1. *Set points* and schedules for *HVAC systems* that *automatically* provide occupant thermal comfort via means other than directly controlling the air dry-bulb and wet-bulb temperature may be allowed to differ, provided that equivalent levels of occupant thermal comfort are demonstrated via the methodology in ASHRAE Standard 55, Section 5.3.3, “Elevated Air Speed,” or Standard 55, Appendix B, “Computer Program for Calculation of PMV-PPD.” 2. When the proposed *building* design includes HVAC systems serving *dwelling units* or *sleeping units* that have controls meeting requirements of Section C406.2.2.4 the baseline shall be modeled using ~~heating and cooling~~ temperature setback of 5°F less than in the *proposed building design* for heating and 5°F greater than in the *proposed building design* for cooling for a total of 9 hours per day. 3. Schedules may be allowed to differ between *proposed design* and *baseline building design* when necessary to model nonstandard *efficiency* measures, provided that the revised schedules have been approved by the *rating authority*. Measures that may warrant use of different schedules include but are not limited to *automatic* lighting *controls*, *automatic* natural *ventilation* *controls*, *automatic* *demand control ventilation* *controls*, and *automatic* *controls* that reduce *service water-heating* loads. In no case shall schedules differ where the *controls* are *manual* (e.g., *manual* operation of light switches or *manual* operation of windows). 4. Fan schedules may be allowed to differ when G3.1.1(c) applies.   5. Lighting schedules shall be allowed to differ based on *occupancy sensor* reduction factor in Table G3.7 |
| 5. *Building Envelope* | | |
| 1. 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. *Thermal bridges* identified in Section 5.4.1.1 shall be modeled using any of the following techniques:    1. a. Separate model of each of these assemblies within the *energy* simulation model.    2. b. By adjusting the wall assembly U-factor in asccordance Sections 5.4.1.1.2 and 5.4.1.1.3. 2. All other 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~~ any 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.     1. When the total area of penetrations from mechanical equipment listed in Tables 6.8.1-4 exceeds 1% of the *opaque* *above*-*grade* *wall* area, then mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5. Where mechanical equipment has been tested in accordance with testing standards approved by the *authority* *having* *jurisdiction*, the mechanical equipment penetration area may be calculated as a separate *wall* *assembly* with the *U-factor* as determined by such test. 2. 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. 4. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface may be modeled with a *reflectance* of 0.30 and a thermal *emittance* of 0.90. 5. *Manual* *fenestration* shading devices, such as blinds or shades, shall be modeled or not modeled the same as in the *baseline building design*. *Automatically* controlled *fenestration* shades or blinds shall be modeled. Permanent shading devices, such as fins, overhangs, and light shelves shall be modeled. 6. *Automatically* controlled *dynamic glazing* may be modeled. Manually controlled *dynamic glazing* shall use the average of the minimum and maximum *SHGC* and *VT*.   b. The above-grade wall surface shall be modeled using the initial solar reflectance and thermal emittance determined in accordance with the test methods identified in Section 5.5.3.2.2(a). Where initial test data are unavailable, the wall surface may be modeled with a solar reflectance of 0.25 and a thermal emittance of 0.9.  c. To simulate air leakage, infiltration shall be modeled using the same methodology and adjustments for weather and *building* operation in both the *proposed design* and the *baseline building design*. These adjustments shall be made for each simulation time step and must account for but not be limited to weather conditions and *HVAC system* operation, including strategies that are intended to positively pressurize the *building*. ~~The air leakage rate of the~~ *~~building envelope~~* ~~(~~*~~I75Pa~~*~~) at a fixed~~ *~~building~~* ~~pressure differential of 0.3 in. of water75 Pa shall be 0.6 cfm/ft~~~~2~~~~3.0 L/s·m~~~~2~~ ~~for buildings providing verification in accordance with Section 5.9.2.2(a)~~. The *air leakage* rate of the *building envelope* shall be converted to appropriate units for the *simulation program* using ~~one of~~ the following method~~s~~ in Section G3.1.1.4.  ~~When whole-building pressurization testing is required or specified during design and completed in accordance with Section 5.4.3.1.4,~~ ~~t~~The measured *air leakage* rate of the *building envelope* (*I75Pa*) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) shall be modeled. ~~for purposes of demonstrating compliance with this Standard~~.    ***Informative Note:*** Before the start of pressurization testing, the maximum *air leakage* rate of the *building envelope* (*I75Pa*) specified in Section 5.4.3.1.4 or as specified in design documents may be simulated to estimate the *energy* impact of *building envelope* *air leakage*. The final measured value shall be used for compliance; therefore, care should be taken when using estimated *air leakage* as a trade-off for performance-based code compliance.     1. ~~For~~ *~~buildings~~* ~~providing verification in accordance with Section 5.9.1.2, the~~ *~~air leakage~~* ~~rate of the~~ *~~building envelope~~* ~~(~~*~~I~~~~75Pa~~*~~) at a fixed~~ *~~building~~* ~~pressure differential of 75 Pa (0.30 in. of water75 Pa) shall be 0.45 cfm/ft~~~~2~~~~2.2 L/s·m~~~~2~~~~.~~   **~~Exception:~~**  ~~When whole-~~*~~building~~* ~~air leakage testing, in accordance with Section 5.9.2.2(b), is specified during design and completed after~~ *~~construction~~*~~, the~~ *~~proposed design~~* ~~air leakage rate of the~~ *~~building envelope~~* ~~shall be as measured~~ | | 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.   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 semiheated 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·ft2 (15 W/m2) 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 Appendix A and shall match the appropriate assembly maximum *U-factors* in Tables G3.4-1 through G3.4-8:   1. Roofs—Insulation entirely above deck (A2.2). 2. Above-grade walls—Steel-framed (A3.3). 3. *Below-grade walls*—Concrete block (A4). 4. Floors—Steel-joist (A5.3). 5. *Slab-on-grade floors* shall match the *F-factor* for unheated slabs from the same tables (A6). 6. *Opaque* *door* types shall be of the same type of *construction* as the *proposed design* and conform to the *U-factor* requirements from the same tables (A7).   ***d. Vertical Fenestration Areas***. For *building* area types included in Table G3.1.1-1, *vertical fenestration areas* for new *buildings* and additions shall equal the percentage ~~that~~ in Table G3.1.1-1 ~~based on the area~~ multiplied by the gross area of ~~gross~~ *above-grade walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior. Where a *building* has multiple *building* area types, each type shall use the values in the table. ~~The~~ *~~vertical fenestration~~* ~~shall be distributed on each face of the~~ *~~building~~* ~~in the same proportion as in the~~ *~~proposed design~~*~~.~~ For *building* areas not shown in Table G3.1.1-1, *vertical fenestration areas* for new *buildings* and additions shall equal that in the *proposed design* or 40% of gross *above-grade wall* area, whichever is smaller, and shall be distributed on each face of the *building* in the same proportions in the *proposed design*.  The *vertical fenestration* shall be distributed on each face of the *building* in the same proportion as in the *proposed design*. If this would cause the combined *vertical fenestration* and *opaque door* area on a given face to exceed the *gross above-grade wall* area on that face, then the *vertical fenestration area* on the other faces shall be increased in proportion to the *gross above-grade wall* area of these faces such that the total baseline *building vertical fenestration* *area* is equal to that calculated following Table G3.1.1-1.  The *fenestration area* for an *existing building* shall equal the existing *fenestration area* prior to the proposed work and shall be distributed on each face of the *building* in the same proportions as the *existing building*.  ***e. Vertical Fenestration* Assemblies**. *Fenestration* for new *buildings*, *existing buildings*, and additions shall comply with the following:   1. *Fenestration* *U-factors* shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 for the applicable glazing percentage for U*all*. 2. *Fenestration* *SHGCs* shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 using the value for *SHGCall* for the applicable vertical glazing percentage. 3. All *vertical fenestration* shall be assumed to be flush with the *exterior wall*, and no shading projections shall be modeled. 4. *Manual* window shading devices such as blinds or shades are not required to be modeled.   ***f. Skylights* and Glazed Smoke Vents**. *Skylight* area shall be equal to that in the *proposed design* or 3%, whichever is smaller. If the *skylight* area of the *proposed design* is greater than 3%, baseline *skylight* area shall be decreased by an identical percentage in all *roof* components in which *skylights* are located to reach 3%. *Skylight* *orientation* and tilt shall be the same as in the *proposed design*. *Skylight* *U-factor* and *SHGC* properties shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 using the value and the applicable *skylight* percentage.  ***g. Roof* Solar Reflectance and Thermal *Emittance***. The exterior *roof* surfaces shall be modeled using a solar reflectance of 0.30 and a thermal *emittance* of 0.90.  ***~~Roof~~* ~~Albedo~~**~~. All~~ *~~roof~~* ~~surfaces shall be modeled with a reflectivity of 0.30.~~  h. The air leakage rate of the *building envelope* (*I75Pa*) at a fixed *building* pressure differential of 0.3 in. of water shall be 1.0 cfm/ft2.  **h. Wall Solar Reflectance and Thermal Emittance**. *Above-grade wall* surfaces shall be modeled with a solar reflectance of 0.25 and a thermal *emittance* of 0.90. |
| 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 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/ft2 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 power for parking garages and *~~building facades~~* 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 (h) and (i).  *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 ft2 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 9.6.2b, the *baseline building design* retail display lighting additional power shall be equal to the limits established by Section 9.6.2b or same as proposed which ever less.  Lighting shall be modeled having the *automatic* shutoff *controls* in *buildings* >5000 ft2 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*. |
| 7. *Thermal Blocks—HVAC Zones* Designed | | |
| Where *HVAC zones* are defined on HVAC design drawings, each *HVAC zone* shall be modeled as a separate *thermal block*.  **Exceptions**: Different *HVAC zones* may be combined to create a single *thermal block* or identical *thermal blocks* to which multipliers are applied, provided that all of the following conditions are met:   1. The *space* use classification is the same throughout the *thermal block* or all of the zones have peak internal loads that differ by less than 10 Btu/h·ft2 from the average. 2. All *HVAC zones* in the *thermal block* that are adjacent to glazed *exterior walls* and glazed *semiexterior walls* face the same *orientation* or their orientations vary by less than 45 degrees. 3. All of the zones are served by the same *HVAC system* or by the same kind of *HVAC system*. 4. All of the zones have schedules that differ by 40 or less equivalent full-load hours per week. | | Same as proposed design. |
| 8. *Thermal Blocks*—*HVAC Zones* Not Designed | | |
| Where the *HVAC zones* and *systems* have not yet been designed, *thermal blocks* shall be defined based on similar internal load densities, occupancy, lighting, thermal and *space* temperature schedules, and in combination with the following guidelines:   1. Separate *thermal blocks* shall be assumed for interior and perimeter *spaces*. Interior *spaces* shall be those located greater than 15 ft from an *exterior wall* or *semiexterior wall*. Perimeter *spaces* shall be those located within 15 ft of an *exterior wall* or *semiexterior wall*. A separate thermal zone does not need to be modeled for areas adjacent to *semiexterior walls* that separate *semiheated space* from *conditioned space*. 2. Separate *thermal blocks* shall be assumed for *spaces* adjacent to glazed *exterior walls* or glazed *semiexterior walls*; a separate zone shall be provided for each *orientation*, except that orientations that differ by less than 45 degrees may be considered to be the same *orientation*. Each zone shall include all *floor* area that is 15 ft or less from a glazed perimeter *wall*, except that *floor* area within 15 ft of glazed perimeter *walls* having more than one *orientation* shall be divided proportionately between zones. 3. Separate *thermal blocks* shall be assumed for *spaces* having *floors* that are in contact with the ground or exposed to ambient conditions from zones that do not share these features. 4. Separate *thermal blocks* shall be assumed for *spaces* having exterior ceiling or *roof* assemblies from zones that do not share these features. | | Same as proposed design. |
| 9. *Thermal Blocks—*Multifamily *Residential Buildings* | | |
| *Residential* *spaces* shall be modeled using at least one *thermal block* per *dwelling unit*, except that those units facing the same orientations may be combined into one *thermal block*. Corner units and units with *roof* or *floor* loads shall only be combined with units sharing these features. | | Same as proposed design. |
| 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:   1. Where a complete *HVAC system* exists, the model shall reflect the actual *system* type using actual component capacities and efficiencies. 2. 2. Where an *HVAC system* has been designed and submitted with design documents, 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 6.4.1 if required by the simulation model. Where *efficiency* ratings include supply fan *energy*, the *efficiency* rating shall be adjusted to remove the supply fan *energy* from the *efficiency* rating in the *baseline building design*. The equations in Section G3.1.2.1 shall not be used in the *proposed design*. The *proposed design* *HVAC system* shall be modeled using *manufacturers*’ full- and part-load data for the *HVAC system* without fan power. 3. 3. Where no heating *system* exists or no heating *system* has been submitted with design documents, the *system* type shall be the same *system* as modeled in the *baseline building design* and shall comply with but not exceed the requirements of Section 6. 4. 4. Where no cooling *system* exists or no cooling *system* has been submitted with design documents, the cooling *system* type shall be the same as modeled in the *baseline building design* and shall comply with the requirements of Section 6.   **Exception:** *Spaces* using baseline *HVAC system* types 9 and 10.   1. *5. Systems* in the *proposed design* that use purchased hot water or purchased steam shall be modeled with the heating provided by forced draft boiler(s) that comply with but not exceed the requirements of Section 6. The number of boilers and boiler control shall be as required in Section G3.2.3.2. 2. Systems in the *proposed design* that use purchased chilled water shall be modeled with the type and number of chillers determined following Section G3.2.3.7, with equipment efficiency and controls that comply with but not exceed the requirements of Section 6. | | The *HVAC systems* in the *baseline building design* shall be of the type and description specified in Section G3.2.1, shall meet the general *HVAC system* requirements specified in Section G3.2.2, and shall meet any *system*-specific requirements in Section G3.2.3 that are applicable to the baseline *HVAC system* types.  If the *proposed design* includes humidification then the *baseline building design* shall use adiabatic humidification.  **Exception:**  If the proposed *building* humidification *system* complies with Section 6.5.2.4 then the *baseline building design* shall use nonadiabatic humidification.  For *systems* serving *computer rooms*, the *baseline building design* shall not have *reheat* for the purpose of dehumidification.  *Fossil fuel* *systems* shall be modeled using natural gas as their *fuel* source.  **~~Exception~~**  ~~For~~ *~~fossil fuel~~**~~systems~~* ~~where natural gas is not available for the proposed~~ *~~building~~* ~~site as determined by the~~ *~~rating authority~~*~~, the baseline~~ *~~HVAC system~~*~~s shall be modeled using propane as their~~ *~~fuel~~*~~.~~ |
| 11. *Service Water-Heating Systems* | | |
| The *service* *water-heating* *system* type and all related performance parameters, such as *equipment* capacities and efficiencies, in the *proposed design* shall be determined as follows:  a. Where a complete *service* *water-heating* *system* exists, the *proposed design* shall reflect the actual *system* type using actual component capacities and efficiencies.  b. Where a *service* *water-heating* *system* has been designed and submitted with design documents, the *service* *water-heating model* shall be consistent with design documents.  c. Where no *service* *water-heating* *system* exists or has been designed and submitted with design documents but the *building* will have *service* *water-heating* loads, a *service* *water-heating* *system* shall be modeled that matches the *system* type in the *baseline building design*, serves the same *water-heating* loads, and shall comply with but not exceed the requirements of Section 7.  d. For *buildings* that will have no *service* *water-heating* loads, no *service* *water-heating* *system* shall be modeled.  e. Where a combined *system* has been specified to meet both *space* heating and *service water-heating* loads, the *proposed design* shall reflect the actual *system* type using actual component capacities and efficiencies.  f. Piping losses shall not be modeled.  g. For *systems* in the *proposed design* using purchased hot water or steam, the *service water heating system* type shall be as specified in Table G3.1.1-2. Each *system* shall be sized according to the provisions of Section 7.4.1 and the equipment shall match the minimum *efficiency* requirements in Section 7.4.2. | | The *service* *water-heating* *system* in the *baseline building design* shall be as specified in Table G3.1.1-2 and conform with the following conditions:   1. Where a complete *service* *water-heating* *system* exists or a new *service* *water-heating* *system* has been specified, one *service water-heating* *system* shall be modeled for each *building* area type in the proposed *building*. Each *system* shall be sized according to the provisions of Section 7.4.1, and the *equipment* shall match the minimum *efficiency* requirements in Section 7.4.2. 2. Where no *service* *water-heating* *system* exists or has been specified but the *building* will have *service* *water-heating* loads, one *service water-heating* *system* shall be modeled for each anticipated *building* area type in the *proposed design*. Each *system* shall meet the minimum *efficiency* requirements of Section 7.4.2 and be modeled identically to the *proposed design*. 3. For *buildings* that will have no *service* *water-heating* loads, no *service* *water-heating* shall be modeled. 4. For large, 24-hour-per-day facilities that meet the prescriptive criteria for use of condenser heat recovery *systems* described in Section 6.5.6.2, a *system* meeting the requirements of that section shall be included in the *baseline building design* regardless of the exceptions to Section 6.5.6.2.   **Exception**  If a condenser heat recovery *system* meeting the requirements described in Section 6.5.6.2 cannot be modeled, the requirement for including such a *system* in the actual *building* shall be met as a prescriptive requirement in accordance with Section 6.5.6.2, and no heat recovery *system* shall be included in the *proposed design* or *baseline building design*.   1. *Service* *water-heating* *energy* consumption shall be calculated explicitly based upon the volume of *service* *water heating* required and the entering makeup water and the leaving *service* *water-heating* temperatures. Entering water temperatures shall be estimated based upon the location. Leaving temperatures shall be based upon the end-use requirements. 2. Where recirculation pumps are used to ensure prompt availability of *service* *water-heating* at the end use, the *energy* consumption of such pumps shall be calculated explicitly. 3. Service water loads and use shall be the same for both the *proposed design* and *baseline building design* and shall be documented by the calculation procedures described in Section 7.4.1.   **Exceptions:**   1. *Service water-heating* use can be demonstrated to be reduced by documented water conservation measures that reduce the physical volume of service water required. Examples include but are not limited to low-flow shower heads and dishwashers. Such reduction shall be demonstrated by calculations. The baseline flow rates shall be determined as described in Table G3.1 #1 and the calculation methodology shall be approved by the *authority having jurisdiction*. 2. *Service water-heating* *energy* consumption can be demonstrated to be reduced by reducing the required temperature of service mixed water, by increasing the temperature, or by increasing the temperature of the entering makeup water. Examples include alternative sanitizing technologies for dishwashing and heat recovery to entering makeup water. Such reduction shall be demonstrated by calculations. 3. *Service* *water heating* use can be demonstrated to be reduced by reducing the hot fraction of mixed water to achieve required operational temperature. Examples include shower or laundry heat recovery to incoming cold-water supply, reducing the hot-water fraction required to meet required mixed-water temperature. Such reduction shall be demonstrated by calculations.      1. Gas storage *water heaters* shall be modeled using natural gas as their *fuel*.   **~~Exception~~**  ~~Where natural gas is not available for the proposed~~ *~~building~~* ~~site, as determined by the~~ *~~rating authority~~*~~, gas storage~~ *~~water heaters~~* ~~shall be modeled using propane as their~~ *~~fuel~~*~~.~~   1. Piping losses shall not be modeled |
| 12. Receptacle and Other Loads | | |
| a. Receptacle and *process loads*, such as those for office and other *equipment*, shall be estimated based on the *building* area type or *space* type category and shall be assumed to be identical in the *proposed design* and *baseline building design*, except as specifically approved by the *rating authority* only when quantifying performance that exceeds the requirements of Standard 90.1 but not when the *Performance Rating Method* is used as an alternative path for minimum standard compliance in accordance with Section 4.2.1.1. These loads shall always be included in simulations of the *building*. These loads shall be included when calculating the *proposed building performance* and the *baseline building performance* as required by Section G1.2.1.  **Exceptions:**  1.When receptacle controls installed in *spaces* where not required by Section 8.4.2 are included in the *proposed building* *design* the hourly receptacle shall be reduced as follows:    *RPC* = *RC* × 10%  Where:  *RPC* = Receptacle power credit  *EPSpro* = *EPSbas* × (1 – *RPC*)  *RC* = Percentage of all controlled receptacles  *EPSbas* = Baseline *equipmen*t power hourly schedule (fraction)  *EPSpro* = Proposed *equipment* power hourly schedule (fraction)      b. Where power and other *systems* covered by Sections 8 and 10 have been designed and submitted with design documents, those *systems* shall be determined in accordance with Sections 8 and 10.    **c.** Where power and other *systems* covered by Sections 8 and 10 have not been submitted with design documents, those *systems* shall comply with but not exceed the requirements of those sections. | | a. Motors shall be modeled as having the *efficiency* ratings found in Table G3.9.1. Other *systems* covered by Section 10 ~~and miscellaneous loads~~ shall be modeled as identical to those in the *proposed design*, including schedules of operation and *control* of the *equipment*.    b. *Energy* used for cooking *equipment*, receptacle loads, computers, medical or laboratory *equipment*, and manufacturing and industrial process *equipment* not specifically identified in the standard power and *energy* rating or capacity of the *equipment* shall be identical between the *proposed building performance* and the *baseline building performance*.    c. Receptacle schedules shall be the same as the *proposed design* before the receptacle power credit is applied.    **Exceptions:** When quantifying performance that exceeds the  requirements of Standard 90.1 (but not when using the *Performance Rating Method* as an alternative path for minimum  standard compliance per Section 4.2.1.1) variations of the  power requirements, schedules, or *control* sequences of the  *equipment* modeled in the *baseline building design* from those  in the *proposed design* shall be approved by the *rating authority*  based on documentation described in Table G3.1, No. 1, or  that the *equipment* installed in the *proposed design* represents  a significant verifiable departure from documented current  conventional practice. The burden of this documentation is to  demonstrate that accepted conventional practice would result  in baseline *building equipment* different from that installed in  the *proposed design*. Occupancy and occupancy schedules  shall not be changed. |
| 13. Modeling Limitations to the *Simulation Program* | | |
| If the *simulation program* cannot model a component or *system* included in the *proposed design* explicitly, substitute a thermodynamically similar component model that can approximate the expected performance of the component that cannot be modeled explicitly. | | Same as proposed design. |
| 14. Exterior Conditions | | |
| 1. **Shading by Adjacent Structures and Terrain**. The effect that structures and significant vegetation or topographical features have on the amount of solar radiation being received by a structure shall be adequately reflected in the computer analysis. All elements whose effective height is greater than their distance from a proposed *building* and whose width facing the proposed *building* is greater than one-third that of the proposed *building* shall be accounted for in the analysis. 2. **Ground Temperatures for *Below-Grade Wall* and Basement *Floor* Heat-Loss Calculations**. It is acceptable to use either an annual average ground temperature or monthly average ground temperatures for calculation of heat loss through *below-grade walls* and basement *floors*. 3. **Water Main Temperatures for *Service Water-Heating* Calculations**. It is acceptable to use either an annual water main supply temperature or monthly average water main supply temperatures for calculating *service water heating*. If annual or monthly water main supply temperatures are not available from the local water utility, annual average ground temperatures may be used. | | Same as proposed design. |
| 15. Distribution *Transformers* | | |
| Low-voltage dry-type distribution *transformers* shall be modeled if the *transformers* in the *proposed design* exceed the *efficiency* required in Table 8.4.4. | | Low-voltage dry-type distribution *transformers* shall be modeled only if the *proposed design* *transformers* exceed the *efficiency* requirements of Table 8.4.4. If modeled, the *efficiency* requirements from Table 8.4.4 shall be used. The ratio of the capacity to peak electrical load of the *transformer* shall be the same as the ratio in the *proposed design*. |
| 16. Elevators | | |
| Where the *proposed* *design* includes elevators, the elevator motor, *ventilation* fan, and light load shall be included in the model. The cab *ventilation* fan and lights shall be modeled with the same schedule as the elevator motor. | | Where the *proposed design* includes elevators, the *baseline building design* shall be modeled to include the elevator cab motor, *ventilation* fans, and lighting power.  The elevator peak motor power shall be calculated as follows:  bhp = (Weight of Car + Rated Load – Counterweight) ×  Speed of Car/(33,000 × *hmechanical*)  *Pm* = bhp × 746/*hmotor*  where  Weight of Car = the *proposed design* elevator car weight, lb  Rated Load = the *proposed design* elevator load at which to operate, lb  Counterweight of Car = the elevator car counterweight, from Table G3.9.2, lb  Speed of Car = the speed of the proposed elevator, ft/min  *hmechanical* = the mechanical *efficiency* of the elevator from Table G3.9.2  *hmotor* = the motor *efficiency* from Table G3.9.2  *Pm* = peak elevator motor power, W  The elevator motor use shall be modeled with the same schedule as the *proposed design*.  When included in the *proposed design*, the baseline elevator cab *ventilation* fan shall be 0.33 W/cfm and the *lighting power density* shall be 3.14 W/ft2; both operate continuously. |
| 17. Refrigeration | | |
| Where refrigeration equipment in the proposed design is rated in accordance with AHRI 1200, the rated energy use shall be modeled. Otherwise, the *proposed design* shall be modeled using the actual *equipment* capacities and efficiencies. | | Where refrigeration *equipment* is specified in the *proposed design* and listed in Tables G3.10.1 and G3.10.2, the *baseline building design* shall be modeled as specified in Tables G3.10.1 and G3.10.2 using the actual *equipment* capacities.  If the refrigeration *equipment* is not listed in G3.10.1 and G3.10.2, the *baseline building design* shall be modeled the same as the *proposed design*. |
| 18. *On-site renewable energy* | | |
| *On-site renewable energy* in the *proposed building performance* shall be determined as follows:   1. Where a complete *system* providing *on-site* *renewable energy* exists, the model shall reflect the actual *system* type using actual component capacities and efficiencies. 2. Where a *system* providing *on-site* *renewable energy* has been designed, the *system* model shall be consistent with design documents. 3. Where no *system* exists or is specified to provide *on-site renewable energy*, no *system* shall be modeled. | | *On-site renewable energy* shall not be included in the *Baseline Building Performance.* |
|  | |  |

**3. CALCULATION OF THE PROPOSED DESIGN AND BASELINE BUILDING PERFORMANCE**

**GG3.1 Building Performance Calculations**

~~The simulation model for calculating the proposed and baseline building performance shall be developed in accordance with the requirements in Table G3.1.~~

**G3.1.1 Scope**

The simulation model for calculating the proposed and *baseline building performance* shall be developed in accordance with Sections G3.1.2 and 3.1.3 as applicable.

**G3.1.2 New Buildings and Additions**

The simulation model for calculating the proposed and *baseline building performance* for new *buildings* shall be developed in accordance with the requirements in Section G3.2.

**G3.1.3 Alterations**

The simulation model for calculating the proposed and *baseline building performance* for *alterations*, excluding *additions*, shall be developed in accordance with the following:

a. In accordance with the requirements in Section G3.2 for *alterations* that include replacement of two or more of the following:

1.  HVAC systems that account for more than 50% of the capacity serving either the heating or cooling loads of the *alteration* area. This includes HVAC unitary systems, HVAC *terminal* units, or components of HVAC central heating or cooling *equipment*. HVAC *terminal* units, for the purposes of this section, can include VAV boxes, fan coil units, VRF room units, or water loop heat pumps

2.  50% or more of the *luminaires* in the *alteration* area

3.  25% or more of the *building envelope* area of the *alteration* portion of the building including new exterior cladding, *fenestration*, or insulation

b. In accordance with the requirements in Section G3.3 for all other *alterations*.

**G3.2 Performance Calculations for New Buildings, Additions and Substantial Alterations**

**G3.2.1 Baseline HVAC System Type and Description**

HVAC *systems* in the *baseline building design* shall be selected based on the *building* area types and criteria described in Section G3.1.1.1 and shall be adjusted, when applicable, based on the requirements in Section G3.1.1.2 and modeled in the *baseline building design* per Section G3.1.1.3 ~~HVAC~~ *~~systems~~* ~~in the~~ *~~baseline building design~~* ~~shall comply with the following:~~

1. ~~HVAC~~ *~~systems~~* ~~in the~~ *~~baseline building design~~* ~~shall be determined in the following order of priority:~~
2. ~~The building type with the largest conditioned floor area.~~
3. ~~Number of floors (including floors above grade and below grade but not including floors solely devoted to parking).~~
4. ~~Conditioned gross floor area.~~
5. ~~Climate zone as specified in Table G3.1.1-3, which shall conform with the system descriptions in Table G3.1.1-4. For Systems 1, 2, 3, 4, 9, 10, 11, 12, and 13, each thermal block shall be modeled with its own HVAC system. For Systems 5, 6, 7, and 8, each floor shall be modeled with a separate HVAC system. Floors with identical thermal blocks can be grouped for modeling purposes~~
6. ~~Use additional~~ *~~system~~* ~~types for nonpredominant conditions (i.e.,~~ *~~residential~~*~~/~~*~~nonresidential~~* ~~or heating source) if those conditions apply to more than 20,000 ft²1900 m² of~~ *~~conditioned~~**~~floor~~**~~area~~*~~.~~

**G3.2.1.1 Baseline HVAC System Types based on Building Area Types.**

*HVAC system* types in the *baseline building design* shall be determined as follows:

1. Determine the combined area of the *gross conditioned floor area* and *semiheated floor area* of each of the following *building* area types in the *proposed design*.
2. **Residential***: HVAC zones* that include *dwelling* *units*, guest rooms, living quarters, private living spaces, and sleeping quarters, and *residential associated HVAC zones* shall be classified as Residential. Other space types, including patient rooms in hospitals, shall not be classified as Residential.
3. **Public Assembly**: Houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers, and natatorium *buildings* shall be classified as Public Assembly. *HVAC zones* that include these area types in other *buildings* shall also be classified as Public Assembly.
4. **Heated-only Storage**: Non-refrigerated warehouse buildings and heated parking garages that are not mechanically cooled, shall be classified as Heated-only Storage.
5. **Retail**: Grocery stores, retail stores and supermarket *buildings* with two floors or fewer shall be classified as Retail.
6. **Hospitals**: Hospital *building* area type including patient rooms.
7. **Other Nonresidential**: *Buildings* and areas within *buildings* that are not classified as Residential, Public Assembly, Heated-only Storage, Hospital or Retail shall be classified as Other Nonresidential.
8. Classify the *nonresidential building* area type with the largest combined area from G3.1.1.1(a) as the predominant *nonresidential building* area type. Add the combined area of any remaining *nonresidential building* area types with less than 20,000 ft² (1900 m²) to the combined area of the predominant *nonresidential building* area type.
9. Select a baseline *HVAC system* type from Table G3.1.1-3 for each of the following *building* area types included in the *proposed design*:
10. Residential based on G3.1.1.1(a),
11. Predominant *nonresidential* based on G3.1.1(b),
12. Each additional *nonresidential building* area type with more than 20,000 ft² (1900 m²) of combined area based on G3.1.1.1(a).

**G3.2.1.2 Additional and Adjusted Baseline HVAC System Types.**

Baseline *HVAC* *systems* shall be added or adjusted for individual *HVAC* *zones* based on the following criteria.

1. If the baseline *HVAC system* type is 5, 6, 7, or 8~~, 9, 10, 11, 12, or 13~~ use separate *single-zone systems* conforming with the requirements of *system* 3 or *system* 4  for any *HVAC zones* that have occupancy, internal gains, or schedules that differ significantly from the rest of the *HVAC zones* served by the *system*. The total peak internal gains that differ by 10 Btu/h·ft2 or more from the average of other *HVAC zones* served by the *system*, or schedules that differ by more than 40 equivalent full-load hours per week from other *HVAC zones* served by the *system,* are considered to differ significantly. Examples where this exception may be applicable include but are not limited to natatoriums and continually occupied security areas. This exception does not apply to *computer rooms*.
2. ~~For laboratory~~ *~~spaces~~* ~~in~~In a *building* having a total laboratory exhaust rate greater than 15,000 cfm, use a single *system* of type 5 or 7 serving only those ~~spaces~~HVAC zones that include the laboratory spaces. The lab exhaust fan shall be modeled as constant horsepower reflecting constant-volume stack discharge with *outdoor air* bypass.
3. ~~Thermal zones~~*HVAC* *zones* designed with heating-only *systems* in the *proposed design* serving storage rooms, stairwells, vestibules, electrical/mechanical rooms, and restrooms not exhausting or transferring air from mechanically cooled thermal zones in the *proposed design* shall use *system* type 9 or 10 in the *baseline building design*.
4. If the baseline HVAC system type is 9 or 10, use additional system types for all HVAC zones that are mechanically cooled in the proposed design. The baseline *HVAC* *system* types for such zones shall be determined based on the *building* area type determined in accordance with G3.1.1.1(a) and the requirements of G3.1.1.1(c).
5. *The* baseline HVAC *system* serving *HVAC* *zones* that include *~~Computer~~computer* *rooms* shall be modeled in accordance with one of the following:
6. Baseline *System* 11 shall be used for such *HVAC* *zones* in *buildings* with a total *computer room* peak cooling load greater than 3,000,000 Btu/h.
7. Baseline System 11 shall be used for such HVAC zones in buildings ~~or a total~~ *~~computer~~**~~room~~* ~~peak cooling load >600,000 Btu/h175 kW~~ where the baseline *HVAC* *system* type is 7 or 8 and the total *computer* *room* peak cooling load is greater than 600,000 BTU/h175kW.
8. Baseline *System* 3 or 4 shall be used for all ~~shall use~~ *~~System~~* ~~11. All~~ other HVAC zones that include *computer* *rooms* based on climate zone.~~shall use~~ *~~System~~* ~~3 or 4.~~

~~f. For hospitals, depending on~~ *~~building~~* ~~type, use System 5 or 7 in all climate zones.~~*Residential* *associated* *HVAC* *zones* shall use *system* type 3 or 4 based on climate zone.

**G3.2.1.3**

For baseline *HVAC* *systems* 1, 2, 3, 4, 9, 10, 11, 12, and 13, each *HVAC* zone or *thermal* *block* shall be modeled with its own *HVAC* *system*. For Systems 5, 6, 7, and 8, each *floor* shall be modeled with a separate *HVAC* *system*. *Floors* with identical *HVAC* *zones* or *thermal* *blocks* can be grouped for modeling purposes.

Exception:

Baseline *system* 5 or 7 serving laboratory *spaces* in accordance with G3.1.1.3(b).

**~~G 3.1.1.4 Purchased Heat~~**

~~For~~ *~~systems~~* ~~using purchased hot water or steam, the heating source shall be modeled as purchased hot water or steam in both the~~ *~~proposed~~**~~design~~* ~~and~~ *~~baseline~~**~~building~~**~~design~~*~~. Hot-water or steam costs shall be based on actual utility rates, and on-site boilers, electric heat, and furnaces shall not be modeled in the~~ *~~baseline~~**~~building~~**~~design~~*~~.~~

**~~G3.1.1.5 Purchased Chilled Water~~**

~~For~~ *~~systems~~* ~~using purchased chilled water, the cooling source shall be modeled as purchased chilled water in both the~~ *~~proposed~~**~~design~~* ~~and~~ *~~baseline~~**~~building~~**~~design~~*~~. Purchased chilled-water costs shall be based on actual utility rates, and on-site chillers and direct expansion~~ *~~equipment~~* ~~shall not be modeled in the~~ *~~baseline~~**~~building~~**~~design~~*~~.~~

**~~G3.1.1.6 Baseline HVAC System Requirements~~ On-Site Distribution Pumpsfor Systems Utilizing Purchased Chilled Water and/or Purchased Heat**

~~If the~~ *~~proposed~~**~~design~~* ~~uses purchased chilled water and/or purchased heat, the following modifications to the baseline~~ *~~HVAC~~**~~system~~* ~~types in Table G3.1.1-4 shall be used.~~

**G3.1.1.6.1 ~~Purchased Heat Only~~**

~~If the~~ *~~proposed~~**~~design~~* ~~uses purchased heat, but does not use purchased chilled water, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline~~ *~~HVAC~~**~~system~~* ~~type, and purchased heat shall be substituted for the heating type in Table G3.1.1-4. The same heating source shall be used in the~~ *~~proposed~~**~~design~~* ~~and~~ *~~baseline~~**~~building~~**~~design~~*~~.~~

**~~G3.1.1.6.2 Purchased Chilled Water Only~~**

~~If the~~ *~~proposed~~**~~design~~* ~~uses purchased chilled water but does not use purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline~~ *~~HVAC~~**~~system~~* ~~type, with the modifications listed below:~~

* + - 1. ~~Purchased chilled water shall be substituted for the cooling types in Table G3.1.1-4.~~
      2. *~~System~~* ~~1 and 2 shall be constant-volume fan-coil units with~~ *~~fossil~~**~~fuel~~**~~boilers~~*~~.~~
      3. *~~System~~* ~~3 and 4 shall be constant-volume single-zone air handlers with~~ *~~fossil~~**~~fuel~~* ~~furnaces.~~
      4. *~~System~~* ~~7 shall be used in place of~~ *~~System~~* ~~5.~~
      5. *~~System~~* ~~8 shall be used in place of~~ *~~System~~* ~~6.~~

**~~G3.1.1.6.3 Purchased Chilled Water and Purchased Heat~~**

~~If the~~ *~~proposed~~**~~design~~* ~~uses purchased chilled water and purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline~~ *~~HVAC~~**~~system~~* ~~type, with the following modifications:~~

* + - 1. ~~Purchased heat and purchased chilled water shall be substituted for the heating types and cooling types in Table G3.1.1-4.~~
      2. *~~System~~* ~~1 shall be constant-volume fan-coil units.~~
      3. *~~System~~* ~~3 shall be constant-volume single-zone air handlers.~~
      4. *~~System~~* ~~7 shall be used in place of~~ *~~System~~* ~~5.~~

**~~G3.1.1.6.4 On-Site Distribution Pumps~~**

~~All on-site distribution pumps shall be modeled in both the~~ *~~proposed~~**~~design~~* ~~and~~ *~~base~~**~~building~~**~~design~~*~~.~~

**G3.2.1.4 Modeling Building Envelope Infiltration**

The air leakage rate of the *building envelope* (*I75Pa*) at a pressure differential of 0.3 in. of water shall be converted to appropriate units for the *simulation program* using one of the following formulas:

For methods describing air leakage as a function of *floor* area.

*IFLR* = 0.112 × *I75Pa* × *S/AFLR*

For methods describing air leakage as a function of the area of *above-grade walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior,

*IAGW* = 0.112 × *I75Pa* × *S/AAGW*

When using the measured air leakage rate of the *building envelope* at a pressure differential of 0.3 in. of water for the *proposed design*, the air leakage rate shall be calculated as follows

*I75Pa* = *Q/S*

where

|  |  |  |
| --- | --- | --- |
| *I75Pa* | = | air leakage rate of the *building envelope* (cfm/ft2) at a fixed *building* pressure differential of 0.3 in. of water, or 1.57 psf |
| *Q* | = | Volume of air in cfm flowing through the *building envelope* when subjected to a pressure differential of 0.3 in. of water, or 1.57 psf, in accordance with ASTM E779 |
| *S* | = | total area of the *building envelope* (ft2), including the lowest floor, any *below-grade walls* or *above-grade walls*, and *roof* (including *vertical fenestration* and *skylights*) |
| *IFLR* | = | adjusted air leakage rate of the *building envelope* (cfm/ft2) at a reference wind speed of 10 mph and relative to the *gross floor area* |
| *AFLR* | = | *gross floor area*, ft2 |
| *IAGW* | = | adjusted air leakage rate of the *building envelope* (cfm/ft2) at a reference wind speed of 10 mph and relative to the area of the *above-grade walls* of the *building envelope* |
| *AAGW* | = | total area of *above-grade walls* of the *building envelope*, ft2 |

**Exception to G3.2.1.4**

A multizone airflow model alternative method to modeling *building envelope* air leakage may be used, provided the following criteria are met:

1. Where the calculations are made independently of the *energy* *simulation program*, the proposed method must comply with Section G2.5.
2. The method for converting the air leakage rate of the *building envelope* at 0.3 in. of water, or 1.57 psf, to the appropriate units for the *simulation program* is fully documented and submitted to the *rating authority* for approval.

**G3.2.2 General Baseline HVAC System Requirements**

*HVAC* systems in the *baseline building* design shall conform with the general provisions in this section.

**G3.2.2.1 Equipment Efficiencies**

All HVAC *equipment* in the *baseline building design* shall be modeled at the minimum *efficiency* levels, both part load and full load, in accordance with Tables G3.5.1 through G3.5.6. Where multiple *HVAC zones* or *residential spaces* are combined into a single *thermal block* in accordance with Table G3.1, the efficiencies (for baseline HVAC System Types 1, 2, 3, 4, 9, and 10) taken from Tables G3.5.1, G3.5.2, G3.5.4, and G3.5.5 shall be based on the equipment capacity of the *thermal block* divided by the number of *HVAC zones* or *residential spaces*. HVAC System Types 5 or 6 efficiencies taken from Table G3.5.1 shall be based on the cooling equipment capacity of a single floor when grouping identical floors in accordance with Section G3.1.1(a)(4). Fan *energy* shall be modeled separately according to Section G3.1.2.9.

*COPnfcooling* and *COPnfheating* are the packaged HVAC *equipment* cooling and heating *energy* *efficiency*, respectively, to be used in the *baseline building design*, which excludes supply fan power.

**G3.2.2.2 Equipment Capacities**

*System* coil capacities for the *baseline building design* shall be based on sizing runs for each *orientation* in accordance with Table G3.1, No. 5[a] and Section G3.1.2.2.1, and shall be oversized by 15% for cooling and 25% for heating. The ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs shall be 1.15 for cooling and 1.25 for heating. Plant capacities shall be based on coincident loads.

**G3.2.2.2.1 Sizing Runs**

Weather conditions used in sizing runs to determine baseline *equipment* capacities shall be based on design days developed using *heating design temperatures*, *cooling design temperature*, and *cooling design wet-bulb temperature*. For cooling sizing runs, schedules for internal loads including those used for infiltration, occupants, lighting, gas and electricity using *equipment* shall be equal to the highest hourly value used in the annual simulation runs and applied to the entire design day. For heating sizing runs, schedules for internal loads including those used for occupants, lighting, gas and electricity using *equipment* shall be equal to the lowest hourly value used in the annual simulation runs and schedules for infiltration shall be equal to the highest hourly value used in the annual simulation runs and applied to the entire design day.

**Exception to G3.~~1~~2.2.2.1**

For cooling sizing runs in *residential dwelling units*, the infiltration, occupants, lighting, gas and electricity using *equipment* hourly schedule shall be the same as the most used hourly weekday schedule from the annual simulation.

**G3.2.2.3 Unmet Loads**

*Unmet load hours* for the *proposed design* or *baseline building design* shall not exceed 300 (of the 8760 hours simulated). Alternatively, *unmet load hours* exceeding these limits shall be permitted to be accepted upon approval of the *rating authority*, provided that sufficient justification is given indicating that the accuracy of the simulation is not significantly compromised by these unmet loads.

**G3.2.2.4 Fan System Operation**

Supply and return fans shall operate continuously whenever *HVAC zones* are occupied and shall be cycled to meet heating and cooling loads during unoccupied hours. Supply, return, and/or exhaust fans will remain on during occupied and unoccupied hours in *HVAC zones* that have health and safety mandated minimum *ventilation* requirements during unoccupied hours.

**Exception to G3.~~1~~2.2.4**

For *Systems* 6 and 8, only the *terminal*-unit fan and *reheat* coil shall be energized to meet heating *set point* during unoccupied hours.

**G3.2.2.5 Ventilation**

Minimum ventilation system outdoor air intake flow shall be the same for the proposed design and baseline building design.

**Exceptions to G3.~~1~~2.2.5**

1. When modeling demand control ventilation in the proposed design in systems with outdoor air capacity less than or equal to 3000 cfm ~~1400 L/s~~ serving areas with an average design capacity of 100 people per 1000 ft ~~293 m2~~ or less.
2. When designing systems in accordance with Standard 62.1, Section 6.2, “Ventilation Rate Procedure,” reduced ventilation airflow rates may be calculated for each HVAC zone in the proposed design with a zone air distribution effectiveness (Ez) > 1.0 as defined by Standard 62.1, Table 6-2. Baseline ventilation airflow rates in those zones shall be calculated using the proposed design Ventilation Rate Procedure calculation with the following change only. Zone air distribution effectiveness shall be changed to (Ez) = 1.0 in each zone having a zone air distribution effectiveness (Ez) > 1.0. Proposed design and baseline building design Ventilation Rate Procedure calculations, as described in Standard 62.1, shall be submitted to the rating authority to claim credit for this exception.
3. Where the minimum outdoor air intake flow in the proposed design is provided in excess of the amount required by the building code or the rating authority, the baseline building design shall be modeled to reflect the greater of that required by either the rating authority or the building code and will be less than the proposed design.
4. For baseline systems serving only laboratory spaces that are prohibited from recirculating return air by code or accreditation standards, the baseline system shall be modeled as 100% outdoor air.

**G3.2.2.6 Economizers**

*Air economizers* shall not be included in baseline *HVAC Systems* 1, 2, 9, and 10. Integrated *air economizer control* shall be included in baseline *HVAC Systems* 3 through 8, and 11, 12, and 13 based on climate as specified in Table G3.1.2.6.

**Exception to G3.~~1~~2.2.6**

Economizers shall not be included for *systems* meeting one or more of the exceptions listed below.

1. *Systems* that include gas-phase air cleaning to meet the requirements of Standard 62.1, Section 6.1.2. This exception shall be used only if the *system* in the *proposed design* does not match the *building* design.
2. Where the use of *outdoor air* for cooling will affect supermarket open refrigerated casework *systems*. This exception shall only be used if the *system* in the *proposed design* does not use an economizer. If the exception is used, an economizer shall not be included in the *baseline building design*.
3. *Systems* that serve *computer rooms* complying with Section G3.1.2.6.1.

**G3.2.2.6.1 Computer Room Economizers**

*Systems* that serve *computer rooms* that are *HVAC System* 3 or 4 shall not have an economizer. *Systems* that serve *computer rooms* that are *HVAC System* 11 shall include an integrated *fluid economizer* meeting the requirements of Section 6.5.1.2 in the *baseline building design*.

**G3.2.2.~~7~~6.2 Economizer High-Limit Shutoff**

The high-limit shutoff shall be a dry-bulb fixed switch with *set point* temperatures in accordance with the values in Table G3.1.2.7.

**G3.2.2.~~8~~7 Design Airflow Rates**

**G3.2.2.~~8~~7.1 Baseline All System Types Except System Types 9 and 10**

*System* design supply airflow rates for the *baseline building design* shall be based on a supply-air-to-room temperature *set point* difference of 20°F or the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards, whichever is greater. For *systems* with multiple zone *thermostat* *set points*, use the design *set point* that will result in the lowest supply air cooling *set point* or highest supply air heating *set point*. If return or relief fans are specified in the *proposed design*, the *baseline building design* shall also be modeled with fans serving the same functions and sized for the baseline *system* supply fan air quantity less the minimum *outdoor air*, or 90% of the supply fan air quantity, whichever is larger.

**Exceptions to G3.~~1~~2.2.8.1**

1. For *systems* serving laboratory *spaces*, airflow rate shall be based on a supply-air-to-room temperature *set point* difference of 17°F or the required *ventilation* air or *makeup air*, whichever is greater.
2. If the *proposed design* *HVAC system* airflow rate based on latent loads is greater than the design airflow rate based on sensible loads, then the same supply-air-to-room-air humidity ratio difference (gr/lb) used to calculate the *proposed design* airflow shall be used to calculate design airflow rates for the *baseline building design*.

**G3.2.2.~~8~~7.2 Baseline System Types 9 and 10**

*System* design supply airflow rates for the *baseline building design* shall be based on the temperature difference between a supply air temperature *set point* of 105°F and the design *space*-heating temperature *set point*, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards, whichever is greater. If the *proposed design* includes a fan or fans sized and controlled to provide non-*mechanical cooling*, the *baseline building design* shall include a separate fan to provide non-*mechanical* cooling, sized and controlled the same as the *proposed design*.

**G3.2.2.~~9~~8 System Fan Power**

*System* fan electrical power for supply, return, exhaust, and relief (excluding power to fan-powered *VAV* boxes) shall be calculated using the following formulas:

For *Systems* 1 and 2,

*Pfan* = CFMs× 0.3

For *Systems* 3 through 8, and 11, 12, and 13,

*Pfan* = bhp × 746 /fan motor *efficiency*

For *Systems* 9 and 10 (supply fan),

*Pfan* = CFMs× 0.3

For *Systems* 9 and 10 (non-*mechanical cooling* fan if required by Section G3.1.2.8.2),

*Pfan* = CFM*nmc* × 0.054

Where

|  |  |  |
| --- | --- | --- |
| *Pfan* | = | electric power to fan power, W |
| bhp | = | brake horsepower of baseline fan motor from Table G3.1.2.9 |
| fan motor *efficiency* | = | the *efficiency* from Table G3.9.1 for the next motor size greater than the bhp |
| CFMs | = | the baseline *system* maximum design supply fan airflow rate, cfm |
| CFM*nmc* | = | the baseline non-*mechanical cooling* fan airflow, cfm |

The calculated *system* fan power shall be distributed to supply, return, exhaust, and relief fans in the same proportion as the *proposed design*.

**G3.2.2.~~10~~9 Exhaust Air Energy Recovery**

Individual fan *systems* that have both a design supply air capacity of 5000 cfm or greater and have a minimum design *outdoor air* supply of 70% or greater shall have an *energy* recovery *system* with at least 50% *enthalpy recovery ratio*. Fifty percent *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 return air at *design conditions*. Provision shall be made to bypass or *control* the heat recovery *system* to permit *air economizer* operation, where applicable.

**Exceptions to G3.~~1~~2.2.~~10~~9**

If any of these exceptions apply, exhaust air *energy* recovery shall not be included in the *baseline building design*:

1. *Systems* serving *spaces* that are not cooled and that are heated to less than 60°F.
2. *Systems* exhausting toxic, flammable, or corrosive fumes or paint or dust. This exception shall only be used if exhaust air *energy* recovery is not used in the *proposed design*.
3. Commercial kitchen hoods (grease) classified as Type 1 by NFPA 96. This exception shall only be used if exhaust air *energy* recovery is not used in the *proposed design*.
4. Heating *systems* in Climate Zones 0 through 3.
5. Cooling *systems* in Climate Zones 3C, 4C, 5B, 5C, 6B, 7, and 8.
6. Where the largest exhaust source is less than 75% of the design *outdoor airflow*. This exception shall only be used if exhaust air *energy* recovery is not used in the *proposed design*.
7. *Systems* requiring dehumidification that employ *energy* recovery in series with the cooling coil. This exception shall only be used if exhaust air *energy* recovery and series-style *energy* recovery coils are not used in the *proposed design*.
8. Systems serving laboratory HVAC zones with a total laboratory exhaust volume greater than 15,000 cfm (7100 L/s).

**G3.2.3 System-Specific Baseline HVAC System Requirements**

Baseline *HVAC systems* shall conform with provisions in this section, where applicable, to the specified baseline *system* types, as indicated in section headings.

**G3.2.3.1 Heat Pumps (Systems 2 and 4)**

Electric air-source heat pumps shall be modeled with electric auxiliary heat and an *outdoor air* *thermostat*. The *systems* shall be controlled to energize auxiliary heat only when the *outdoor air* temperature is less than 40°F . The air-source heat pump shall be modeled to continue to operate while auxiliary heat is energized.

**G3.2.3.2 Type and Number of Boilers (Systems 1, 5, 7, 11, and 12)**

The *boiler* plant shall be natural draft, except as noted in Section G3.1.1.1. The *baseline building design* *boiler* plant shall be modeled as having a single *boiler* if the *baseline building design* plant serves a *conditioned floor area* of 15,000 ft2 or less, and as having two equally sized *boilers* for plants serving more than 15,000 ft2. *Boilers* shall be staged as required by the load.

**G3.2.3.3 Hot-Water Supply Temperature (Systems 1, 5, 7, 11, and 12)**

Hot-water design supply temperature shall be modeled as 180°F and design return temperature as 130°F.

**G3.2.3.4 Hot-Water Supply Temperature Reset (Systems 1, 5, 7, 11, and 12)**

Hot-water supply temperature shall be *reset* based on outdoor dry-bulb temperature using the following schedule: 180°F at 20°F and below, 150°F at 50°F and above, and ramped linearly between 180°F and 150°F at temperatures between 20°F and 50°F.

**Exception to G3.~~1~~2.3.4**

*Systems* served by purchased heat.

**G3.2.3.5 Hot-Water Pumps**

The *baseline building design* hot-water pump power shall be 19 W/gpm. The pumping *system* shall be modeled as primary-only with continuous variable flow and a minimum of 25% of the design flow rate. Hot-water *systems* serving 120,000 ft2 or more shall be modeled with variable-speed drives, and *systems* serving less than 120,000 ft2 shall be modeled as riding the pump curve.

**Exception to G3.~~1~~2.3.5**

The pump power for *systems* using purchased heat shall be 14 W/gpm.

**G3.~~1~~2.3.6 Piping Losses (Systems 1, 5, 7, 8, 11, 12, and 13)**

*Piping* losses shall not be modeled in either the *proposed design* or *baseline building design* for hot-water, chilled-water, or steam *piping*.

**G3.~~1~~2.3.7 Type and Number of Chillers (Systems 7, 8, 11, 12, and 13)**

Electric chillers shall be used in the *baseline building design* regardless of the cooling *energy* source, e.g. direct-fired absorption or absorption from purchased steam. The *baseline building design*’s chiller plant shall be modeled with chillers having the number and type as indicated in Table G3.1.3.7 ~~as a function of~~ based on the *building* peak coincident cooling load of baseline *HVAC* *systems* using chilled water.

**Exception to G3.~~1~~2.3.7**

*Systems* using purchased chilled water shall be modeled in accordance with Section G3.1.1.3.

**G3.~~1~~2.3.8 Chilled-Water Design Supply Temperature (Systems 7, 8, 11, 12, and 13)**

Chilled-water design supply temperature shall be modeled at 44°F and return water temperature at 56°F.

**G3.~~1~~2.3.9 Chilled-Water Supply Temperature Reset (Systems 7, 8, 11, 12, and 13)**

Chilled-water supply temperature shall be *reset* based on outdoor dry-bulb temperature using the following schedule: 44°F at 80°F and above, 54°F at 60°F and below, and ramped linearly between 44°F and 54°F at temperatures between 80°F and 60°F.

**Exceptions to G3. ~~1~~2.3.9**

1. If the baseline chilled-water *system* serves a *computer room HVAC system*, the supply chilled-water temperature shall be *reset* higher based on the *HVAC system* requiring the most cooling; i.e., the chilled-water *set point* is *reset* higher until one cooling-coil valve is nearly wide open. The maximum *reset* chilled-water supply temperature shall be 54°F.
2. *~~Systems~~* ~~served by purchased chilled water.~~

**G3.~~1~~2.3.10 Chilled-Water Pumps (Systems 7, 8, 11, 12, and 13)**

Chilled-water *systems* shall be modeled as primary/secondary *systems* with constant-flow primary loop and variable-flow secondary loop. For *systems* with cooling capacity of 300 tons or more, the secondary pump shall be modeled with variable-speed drives and a minimum flow of 25% of the design flow rate. For *systems* with less than 300 tons cooling capacity, the secondary pump shall be modeled as riding the pump curve. The baseline *building* constant-volume primary pump power shall be modeled as 9 W/gpm, and the variable-flow secondary pump power shall be modeled as 13 W/gpm at *design conditions*. For *computer room* *systems* using *System* 11 with an integrated *fluid economizer*, the *baseline building design* primary chilled-water pump power shall be increased by 3 W/gpm for flow associated with the *fluid economizer*.

**Exception to G3.~~1~~2.3.10**

For *systems* using purchased chilled water, the *building* distribution pump shall be modeled with variable-speed drive, a minimum flow of 25% of the design flow rate, and a pump power of 16 W/gpm.

**G3.~~1~~2.3.11 Heat Rejection (Systems 7, 8, 11, 12, and 13)**

The heat-rejection device shall be an axial-fan open-circuit cooling tower with variable-speed fan *control* and shall have an *efficiency* of 38.2 gpm/hp at the conditions specified in Table 6.8.1-7. Condenser-water design supply temperature shall be calculated using the cooling tower approach to the 0.4% *evaporation design wet-bulb temperature* as generated by the formula below, with a design temperature rise of 10°F:

Approach 10°F *Range* = 25.72 – (0.24 × WB)

where WB is the 0.4% *evaporation design wet-bulb temperature* (°F); valid for wet bulbs from 55°F to 90°F.

The tower shall be controlled to maintain a leaving water temperature, where weather permits, per Table G3.1.3.11, floating up to the design leaving water temperature for the cooling tower. The *baseline building design* condenser-water pump power shall be 19 W/gpm and modeled as constant volume. For *computer room* *systems* using *System* 11 with an integrated *fluid economizer*, the *baseline building design* condenser-water-pump power shall be increased by 3 W/gpm for flow associated with the *fluid economizer*. Each chiller shall be modeled with separate condenser-water and chilled-water pumps interlocked to operate with the associated chiller.

**G3.~~1~~2.3.12 Supply Air Temperature Reset (Systems 5 through 8 and 11)**

The air temperature for cooling shall be *reset* higher by 5°F under the minimum cooling load conditions.

**G3.~~1~~2.3.13 VAV Minimum Flow Set Points (Systems 5 and 7)**

Minimum volume *set points* for *VAV reheat* boxes shall be 30% of zone peak airflow, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards, whichever is larger.

**Exception to G3.1.3.13**

*Systems* serving laboratory *spaces* shall reduce the exhaust and *makeup air* volume during unoccupied periods to the largest of 50% of zone peak airflow, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards.

**G3.~~1~~2.3.14 Fan Power and Control (Systems 6 and 8)**

Fans in parallel *VAV* fan-powered boxes shall run as the first stage of heating before the *reheat* coil is energized. Fans in parallel *VAV* fan-powered boxes shall be sized for 50% of the peak design primary air (from the *VAV* air-handling unit) flow rate and shall be modeled with 0.35 W/cfm fan power. Minimum volume *set points* for fan-powered boxes shall be equal to 30% of peak design primary airflow rate or the rate required to meet the minimum *outdoor air* *ventilation* requirement, whichever is larger. The supply air temperature *set point* shall be constant at the *design condition*.

**G3.~~1~~2.3.15 VAV Fan Part-Load Performance (Systems 5 through 8 and 11)**

*VAV* *system* supply fans shall have variable-speed drives, and their part-load performance characteristics shall be modeled using either Method 1 or Method 2 specified in Table G3.1.3.15.

**G3.~~1~~2.3.16 Computer Room Equipment Schedules**

*Computer room* *equipment* schedules shall be modeled as a constant fraction of the peak design load per the following monthly schedule:

* Month 1, 5, 9—25%
* Month 2, 6, 10—50%
* Month 3, 7, 11—75%
* Month 4, 8, 12—100%

**G3.~~1~~2.3.17 Computer Room Equipment Schedules**

Minimum volume *set point* shall be 50% of the maximum design airflow rate, the minimum *ventilation* outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards, whichever is larger.

Fan volume shall be *reset* from 100% airflow at 100% cooling load to minimum airflow at 50% cooling load. Supply air temperature *set point* shall be *reset* from minimum supply air temperature at 50% cooling load and above to *space* temperature at 0% cooling load. In heating mode supply air temperature shall be modulated to maintain *space* temperature, and fan volume shall be fixed at the minimum airflow.

**G3.~~1~~2.3.18 Computer Room Equipment Schedules**

If the proposed design HVAC systems have humidistatic controls, then the baseline building design shall use mechanical cooling for dehumidification and shall have reheat available to avoid overcooling. When the baseline building design HVAC system does not comply with any of the exceptions in Section 6.5.2.3, then only 25% of the system reheat energy shall be included in the baseline building performance. The reheat type shall be the same as the system heating type.

**G3.~~1~~2.3.19 Preheat Coils (Systems 5 through 8)**

The baseline *system* shall be modeled with a preheat coil controlled to a fixed *set point* 20°F less than the design room heating temperature *set point*.

**G3.3 Performance Calculations for Other Alter~~n~~ations**

**G3.3.1 Proposed Building Performance**

The simulation model for calculating the *proposed* *building* *performance* shall be developed in accordance with the requirements in Table G3.1, Proposed Building Performance column and the following additional requirements:

1. New and retrofitted *systems* and *equipment* shall be consistent with design documents.
2. Systems and equipment excluded from the scope of retrofit shall reflect the existing conditions

**G3.3.2 Baseline Building Performance**

**G3.3.2.1 General Approach**

*System* and equipment included in the scope of retrofit shall be modeled at efficiency levels meeting the mandatory and prescriptive requirements in Sections 5 – 10 and as described in this section. All other baseline *systems* and equipment shall be modeled the same as in the *proposed* *design*.

**G3.3.2.2 Schedules**

Schedules modeled in the *baseline* *design* are allowed to differ from the *proposed* *design* following Table G3.1 #4, Baseline Building Performance column, exceptions 1-3.

**G3.3.2.3 Opaque Assemblies**

Opaque assemblies shall be modeled with U-factors meeting the requirements in Section 5.1.3

**G3.3.2.4 Fenestration**

*Fenestration* *U-factor*, *SHGC* and *VT* shall be modeled as meeting the requirements in Section 5.1.3.

The *fenestration* *area* for an *existing* *building* shall equal the existing *fenestration* *area* prior to the proposed work and shall be distributed on each face of the *building* in the same proportions as the *existing* *building*.

**G3.3.2.5 Air Leakage**

When exception to 5.4.3.1.1 ~~Section 5.4.3.1.3~~ applies, the *air* *leakage* rate of the *building* *envelope* (*I*75Pa) shall be equal to ~~0.35~~ 0.40 cfm/ft² ~~(1.5 L/s·m²)~~ of *building* *envelope* area at a pressure differential of 75 Pa (0.30 of water) ~~(75 Pa)~~. The *air* *leakage* rate shall be converted to appropriate units for the simulation software using the same method as the *proposed* *design*.

**G3.3.2.6 Interior Lighting**

Interior *lighting* *power* *density* shall be modeled as meeting Section 9.1.2 using allowances in Section 9.6.1, Space-by-Space method. Lighting *controls* shall be modeled as meeting Section 9.1.2.

**G3.3.2.7 Exterior Lighting**

Tradeable exterior lighting shall be modeled as meeting Section 9.1.2.

**G3.3.2.8 HVAC Systems**

1. Baseline HVAC system types shall be the same as the *proposed* *design*.

**Exception:**  
If the *proposed* *design* includes variable refrigerant heat pumps or single zone systems with electric resistance heat, then air source heat pumps shall be used in the *baseline* *design*.

2.  *Baseline* *systems* shall meet the requirements in Section 6.1.1.3. Chillers shall meet the efficiency requirements in Table 6.8.1-3 using Path A or Path B, the same as the *proposed* *design*. If the *proposed* *design* meets both Path A and Path B requirements, Path A shall be used.

3.  Where the *efficiency* rating includes supply fan energy, calculate the minimum *COPnfcooling* and COPnfheating ~~shall be modeled following Section 11.5.2 (c)~~  as follows:

*COPnfcooling* = 0.3322 × *EER* – 0.2145

(applies to packaged terminal air conditioners and heat pumps)

*COPnfcooling* = 7.84E-8 × *EER* × *Q* + 0.338 × *EER*

*COPnfcooling* = –0.0076 × SEER2 + 0.3796 × *SEER*

*COPnfheating* = 1.1329 × *COP* – 0.214

(applies to packaged terminal heat pumps)

*COPnfheating* = 1.48E-7 × *COP47* × *Q* + 1.062 × *COP47*

(applies to other heat pumps)

*COPnfheating* = –0.0296 × HSPF2 + 0.7134 × *HSPF*

4.    Fan *system* *efficiency* (bhp per cfm of supply air, including the effect of belt losses but excluding motor and motor drive losses) shall be the same as the *proposed* *design* or up to the limit prescribed in Section 6.5.3.1, whichever is smaller. If this limit is reached, each fan shall be proportionally reduced in brake horsepower until the limit is met. Fan electrical power shall then be determined by adjusting the calculated fan hp by the minimum motor efficiency prescribed by Section 10.4.1 for the appropriate motor size for each fan.

**Exception:**

When a *proposed* *design* includes energy recovery but it is not required in the *baseline* *building* *design* per Section 6.5.6, the fan power of the baseline *system* shall be equal to either the *proposed* *design* *system* or the fan power limit in 6.5.3.1 calculated without fan power credit for energy recovery, whichever is less.

5. The equipment capacities for the *baseline* *design* shall be sized proportionally to the capacities in the *proposed* *design* based on sizing runs, i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs shall be the same for both the proposed design and budget building design.

**G3.3.2.9 Service Water-Heating Systems**

Service *water*-*heating* systems be modeled as meeting Section 7.1.1.3. Service water heating energy use can be documented to be reduced as allowed in Table G3.1 #11 *Baseline* *Building* *Performance* Column Exceptions to (g).

**Table G3.1.1-1   Baseline *Building Vertical Fenestration* Area**

|  |  |
| --- | --- |
| ***Building* Area Types** | **Baseline *Building* Vertical Fenestration Area as a Percentage of Gross *Above-Grade-Wall* Area** |
| Grocery store | 7% |
| Healthcare (outpatient) | 21% |
| Hospital | 27% |
| Hotel/motel (≤75 rooms) | 24% |
| Hotel/motel (>75 rooms) | 34% |
| Multifamily (≤20 stories) | 27% |
| Office (≤5000 ft2) | 19% |
| Office (5000 ft2 to 50,000 ft2) | 31% |
| Office (>50,000 ft2) | 40% |
| Restaurant (quickservice) | 34% |
| Restaurant (fullservice) | 24% |
| Retail (stand alone) | 11% |
| Retail (strip mall) | 20% |
| School (primary) | 22% |
| School (secondary and university) | 22% |
| Warehouse (nonrefrigerated) | 6% |

**Table G3.1.1-2   Baseline Service Water-Heating System**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Building* Area Type** | **Baseline Heating Method** | ***Building* Area Type** | **Baseline Heating Method** | |
| Automotive facility | Gas storage *water heater* | Multifamily | Gas storage *water heater* | |
| Convenience store | *Electric resistance water heater* | Museum | *Electric resistance water heater* | |
| Convention center | *Electric resistance water heater* | Office | *Electric resistance water heater* | |
| Courthouse | *Electric resistance water heater* | Parking garage | *Electric resistance water heater* | |
| Dining: Bar lounge/leisure | Gas storage *water heater* | Penitentiary | Gas storage *water heater* | |
| Dining: Cafeteria/fast food | Gas storage *water heater* | Performing arts theater | Gas storage *water heater* | |
| Dining: Family | Gas storage *water heater* | Police station | *Electric resistance* storage *water heater* | |
| Dormitory | Gas storage *water heater* | Post office | *Electric resistance* storage *water heater* | |
| Exercise center | Gas storage *water heater* | Religious *facility* | *Electric resistance* storage *water heater* | |
| Fire station | Gas storage *water heater* | Retail | *Electric resistance* storage *water heater* | |
| Grocery store | Gas storage *water heater* | School/university | Gas storage *water heater* | |
| Gymnasium | Gas storage *water heater* | Sports arena | Gas storage *water heater* | |
| Health-care clinic | *Electric resistance water heater* | Town hall | | *Electric resistance* storage *water heater* |
| Hospital and outpatient surgery center | Gas storage *water heater* | Transportation | | *Electric resistance* storage *water heater* |
| Hotel | Gas storage *water heater* | Warehouse | | *Electric resistance* storage *water heater* |
| Library | *Electric resistance water heater* | Workshop | | *Electric resistance* storage *water heater* |
| Manufacturing facility | Gas storage *water heater* | All others | | Gas storage *water heater* |
| Motel | Gas storage *water heater* |  | |  |
| Motion picture theater | *Electric resistance water heater* |  | |  |

**Table G3.1.1-3   Baseline *HVAC System* Types**

|  |  |  |
| --- | --- | --- |
| ***Building* Area Types, Number of Floors2, and ~~Gross~~ ~~Conditioned~~ Combined Floor Area3** | **Climate Zones 3B, 3C, and 4 to 8** | **Climate Zones 0 to 3A** |
| Residential | *System* 1—*PTAC* | *System* 2—*PTHP* |
| Public assembly area smaller than 120,000 ft2 | *System* 3—PSZ-AC | *System* 4—PSZ-HP |
| Public assembly ≥area equal to or larger than 120,000 ft2 | *System* 12—SZ-CV-HW | *System* 13—SZ-CV-Er |
| Heated-only storage | *System* 9—Heating and *ventilation* | *System* 10—Heating and *ventilation* |
| Retail in a building that is 1 or ~~and~~ 2 ~~floors~~ floors ~~or fewer~~ | *System* 3—PSZ-AC | *System* 4—PSZ-HP |
| Hospital that is either:  • larger than 150,000 ft2(14,000 m2), or  • in a *building* greater than 5 floors | *System* *7 –VAV* with *reheat* | *System* *7 –VAV* with *reheat* |
| Hospital – All Other | *System* *5* *–* Packaged *VAV* with *reheat* | *System* *5* *–* Packaged *VAV* with *reheat* |
| Other Nonresidential area that is both:   * smaller than 25,000 ft²300m², and * in a building 3 floor or fewer~~and 3 floors or fewer and <25,000 ft²2300 m²~~ | *System* 3—PSZ-AC | *System* 4—PSZ-HP |
| Other ~~nonresidential~~ Nonresidential area that is both:   1. smaller than ~~and 4 or 5 floors and <~~ 25,000 ft2, and 2. in a building with 4 or 5 floors  ~~or~~ ~~5~~ *~~floors~~* ~~or fewer and 25,000 ft22300 m2 to 150,000 ft²14,000 m²~~ | *System* 5—Packaged *VAV* with *reheat* | *System* 6—Packaged *VAV* with PFP boxes |
| Other Nonresidential area that is both:   1. 25,000 ft²2300m² to 150,000 ft²14,000m², and 2. in a building that is 5 floor or fewer | *System* 5—Packaged *VAV* with *reheat* | *System* 6—Packaged *VAV* with PFP boxes |
| Other Nonresidential area that is both:   1. larger than and more than 5 *floors* or >150,000 ft² 2. in a building greater than 5 floors | *System* 7—*VAV* with *reheat* | *System* 8—*VAV* with PFP boxes |

Notes

1. *~~Residential~~**~~building~~* ~~types include dormitory, hotel, motel, and multifamily. Residential space types include guest rooms, living quarters, private living space, and sleeping quarters. Other~~ *~~building~~* ~~and~~ *~~space~~* ~~types are considered~~ *~~nonresidential~~*
2. ~~Where attributes make a~~ *~~building~~* ~~eligible for more than one baseline~~ *~~system~~* ~~type, use the predominant condition to determine the~~ *~~system~~* ~~type for the entire~~ *~~building~~* ~~except as noted in Section G3.1.1~~.
3. ~~For laboratory spaces in a~~ *~~building~~* ~~having a total laboratory exhaust rate greater than 15,000 cfm7100 L/s, use a single~~ *~~system~~* ~~of type 5 or 7 serving only those~~ *~~spaces~~*
4. ~~For hospitals, depending on~~ *~~building~~* ~~type, use~~ *~~System~~* ~~5 or 7 in all climate zones~~
5. ~~Public assembly~~ *~~building~~* ~~types include houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers, and natatoriums~~
6. Building area type determined in accordance with G3.1.1.1.
7. The total number of floors in a building, including above-grade and below-grade floors but not including floors solely devoted to parking.
8. Combined gross conditioned floor area and semiheated floor area, of the building area type, based on the requirements of G3.1.1.1.

**Table G3.1.1-4   Baseline *System* Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **System No.** | **System Type** | **Fan Control** | **Cooling Typea** | **Heating Typea** |
| 1. *PTAC* | *Packaged terminal air conditioner* | Constant volume | Direct expansion | Hot-water *fossil fuel boiler* |
| 2. *PTHP* | *Packaged terminal heat pump* | Constant volume | Direct expansion | Electric heat pump |
| 3. PSZ-AC | Packaged rooftop air conditioner | Constant volume | Direct expansion | *Fossil fuel* furnace |
| 4. PSZ-HP | Packaged rooftop heat pump | Constant volume | Direct expansion | Electric heat pump |
| 5. Packaged *VAV* with *reheat* | Packaged rooftop *VAV* with *reheat* | *VAV* | Direct expansion | Hot-water *fossil fuel boiler* |
| 6. Packaged *VAV* with PFP boxes | Packaged rooftop *VAV* with parallel fan power boxes and reheat | *VAV* | Direct expansion | *Electric resistance* |
| 7. *VAV* with *reheat* | *VAV* with *reheat* | *VAV* | Chilled water | Hot-water *fossil fuel boiler* |
| 8. *VAV* with PFP boxes | *VAV* with parallel fan-powered boxes and *reheat* | *VAV* | Chilled water | *Electric resistance* |
| 9. Heating and *ventilation* | Warm air furnace, gas fired | Constant volume | None | *Fossil fuel* furnace |
| 10. Heating and *ventilation* | Warm air furnace, electric | Constant volume | None | *Electric resistance* |
| 11. SZ-*VAV* | Single-zone *VAV* | *VAV* | Chilled water | See note (b). |
| 12. SZ-CV-HW | *Single-zone system* | Constant volume | Chilled water | Hot-water *fossil fuel boiler* |
| 13. SZ-CV-ER | *Single-zone system* | Constant volume | Chilled water | *Electric furnace* |

1. For purchased chilled water and purchased heat, see G3.1.1.3
2. For Climate Zones 0 through 3A, the heating type shall be *electric resistance*. For all other climate zones the heating type shall be hot-water *fossil fuel boiler*.

.................

|  |  |  |
| --- | --- | --- |
| **Table G3.7 *Performance Rating Method* *Lighting Power Density* Allowances and *Occupancy sensor* Reductions Using the Space-by-Space Method** | | |
| **Common *Space* Typesa** | **Lighting Power Density, W/m2** | ***Occupancy sensor* Reductionb,c,d, e** |
| **Audience Seating Area** | | |
| Auditorium | 9.69 | 10% |
| Convention center | 7.53 | 10% |
| Exercise center | 3.23 | 10% |
| Gymnasium | 4.41 | 10% |
| Motion picture theater | 12.92 | 10% |
| Penitentiary | 7.53 | 10% |
| Performing arts theater | 27.99 | 10% |
| Religious facility | 18.30 | 10% |
| In a sports arena | 4.31 | 10% |
| Transportation facility | 5.38 | 10% |
| All other audience seating area | 9.69 | 10% |
| **Atrium** | | |
| <12.2 m in height | 0.404 per metre in total height | 10% |
| >12.2 m in height | 5.382 + 0.269 per foot in total height | 10% |
| **Banking Activity Area** | 16.15 | 10% |
| **Breakroom (See Lounge/Breakroom)** | | |
| **Classroom/Lecture Hall/Training Room** | | |
| Penitentiary | 13.99 | None |
| Preschool through 12th grade, laboratory, and shop classrooms | 15.07 | 30% |
| All other classroom/lecture hall/training room | 15.07 | None |
| **Conference/Meeting/Multipurpose Room** | 13.99 | None |
| **Confinement Cells** | 9.69 | 10% |
| **Copy/Print Room** | 9.69 | 10% |
| **Corridor** | | |
| Facility for the visually impaired (and used primarily by residents) | 12.38 | 25% |
| Hospital | 10.76 | 25% |
| Manufacturing facility | 5.38 | 25% |
| All other corridor | 5.38 | 25% |
| **Courtroom** | 20.45 | 10% |
| **Computer Room** | 23.03 | 35% |
| **Dining Area** | | |
| Penitentiary | 13.99 | 35% |
| Facility for the visually impaired (and used primarily by residents) | 35.74 | 35% |
| Bar/lounge or leisure dining | 15.07 | 35% |
| Cafeteria or fast food dining | 9.69 | 35% |
| Family dining | 22.60 | 35% |
| All other dining area | 9.69 | 35% |
| **Electrical/Mechanical Room** | 16.15 | 30% |
| **Emergency Vehicle Garage** | 8.61 | 10% |
| **Food Preparation Area** | 12.92 | 30% |
| **Guest Room** | 11.84 | 45% |
| **Judges Chambers** | 13.99 | 30% |
| **Dwelling Unit e** | 11.5 | None |
| **Laboratory** | | |
|  |  |  |
| All other laboratory except in or as a classroom | 15.07 | 10% |
| **Laundry/Washing Area** | 6.46 | 10% |
| **Loading Dock, Interior** | 6.35 | 10% |
| **Lobby** | | |
| Facility for the visually impaired (and used primarily by residents) | 24.33 | 25% |
| Elevator | 8.61 | 25% |
| Hotel | 11.84 | 25% |
| Motion picture theater | 11.84 | 25% |
| Performing arts theater | 35.52 | 25% |
| All other lobby | 13.99 | 25% |
| ***Locker Room*** | 6.46 | 25% |
| ***Lounge/Breakroom*** | | |
| Healthcare facility | 8.61 | None |
| All other lounge/breakroom | 12.92 | None |
| **Office** | | |
| Enclosed | 11.84 | 30% |
| Open plan | 11.84 | 15%c |
| **Parking Area, Interior** | 2.15 | 15% |
| **Pharmacy Area** | 12.92 | 10% |
| **Restroom** | | |
| Facility for the visually impaired (and used primarily by residents) | 16.36 | 45% |
| All other restroom | 9.69 | 45% |
| **Sales Area** | 18.30 | 15% |
| **Seating Area, General** | 0.68 | 10% |
| **Stairwell** | 6.46 | 75% |
| **Storage Room** | | |
| Hospital | 9.69 | 45% |
| *³*50 ft2 | 8.61 | 45% |
| <50 ft2 | 8.61 | 45% |
| **Vehicular Maintenance Area** | 7.53 | 10% |
| **Workshop** | 20.45 | 10% |

|  |  |  |
| --- | --- | --- |
| ***Building* Type Specific *Space* Typesa** | ***Lighting Power Density*, W/m2** | ***Occupancy sensor* Reductionb,c,d, e** |
| **Assisted Living Facility** | | |
| Chapel (used primarily by residents) | 29.82 | 10% |
| Recreation room (used primarily by residents) | 32.51 | 10% |
| **Automotive (See “Vehicular Maintenance Area”)** | | 10% |
| **Convention Center—Exhibit *Space*** | 13.99 | 35% |
| **Dormitory—Living Quarters** | 11.95 | 10% |
| **Fire Station—Sleeping Quarters** | 3.23 | 10% |
| **Gymnasium/Fitness Center** | | |
| Exercise area | 9.69 | 35% |
| Playing area | 15.07 | 35% |
| **Healthcare Facility** | | |
| Emergency room | 29.06 | 10% |
| Exam/treatment room | 16.15 | 10% |
| Medical supply room | 15.07 | 45% |
| Nursery | 6.46 | 10% |
| Nurse's station | 10.76 | 10% |
| Operating room | 23.68 | 10% |
| Patient room | 7.53 | 10% |
| Physical therapy room | 9.69 | 10% |
| Recovery room | 8.61 | 10% |
| **Library** | | |
| Reading area | 12.92 | 15% |
| Stacks | 18.30 | 15% |
| **Manufacturing Facility** | | |
| Detailed manufacturing area | 22.60 | 10% |
| *Equipment* room | 12.92 | 10% |
| Extra-high bay area (>50 ft *floor*-to-ceiling height) | 14.31 | 10% |
| High bay area (25 to 50 ft *floor*-to-ceiling height) | 18.30 | 10% |
| Low bay area (<25 ft *floor*-to-ceiling height) | 12.92 | 10% |
| **Museum** | | |
| General exhibition area | 10.76 | 10% |
| Restoration room | 18.30 | 10% |
| **Post Office—Sorting Area** | 12.92 | 10% |
| **Religious Facility** | | |
| Fellowship hall | 9.69 | 10% |
| Worship/pulpit/choir area | 25.83 | 10% |
| **Retail Facilities** | | |
| Dressing/fitting room | 9.58 | 10% |
| Mall concourse | 18.30 | 10% |
| **Sports Arena—Playing Area** | | |
| Class I facility | 49.62 | 10% |
| Class II facility | 32.40 | 10% |
| Class III facility | 24.33 | 10% |
| Class IV facility | 16.15 | 10% |
| **Transportation Facility** | | |
| Baggage/carousel area | 10.76 | 10% |
| Airport concourse | 6.46 | 10% |
| Ticket counter | 16.15 | 10% |
| **Warehouse—Storage Area** | | |
| Medium to bulky, palletized items | 9.69 | 45% |
| Smaller, hand-carried items | 15.07 | 45% |
| a.In cases where both a common *space* type and a *building* area specific *space* type are listed, the *building* area specific *space* type shall apply  b.For *manual*-on or partial-auto-on *occupancy sensors*, the *occupancy sensor* reduction factor shall be multiplied by 1.25.  c.For *occupancy sensors* controlling individual workstation lighting, *occupancy sensor* reduction factor shall be 30%. | | |

d.F*or luminaire* that meet requirements of C406.2.5.2 (energy credit L02) ~~7.5% shall be added to~~ the *occupancy sensor* reduction factor shall be increased by 7.5%.

e. For lighting in the *dwelling units* that have controls meeting the requirements of C406.2.5.5 (energy credit L05) the *occupancy senor* reduction factor shall be 10%.

## Amendment of Normative Appendix H

Amend Appendix H of ASHRAE 90.1-2019 as follows:

Table H-3 Standard 90.1 Items to Verify

|  |  |  |  |
| --- | --- | --- | --- |
| **Subsection** | **Subsection Title** | **Standard 90.1 Items to Verify for Proper Operation or Inclusion** | **Status** |
| 10.4.5 | Air Curtains | Functional testing and adjustment per the manufacturer’s installation requirements |  |

## Addition of New Section Normative Appendix J

**NORMATIVE APPENDIX J— MECHANICAL SYSTEM PERFORMANCE RATING METHOD.**

**J1** **GENERAL**

**J1.1 Scope**

The Mechanical *System* Performance Rating Method described in this appendix is an optional path for compliance where the following conditions are met:

1. All *HVAC* *systems* in the *building* that meet the criteria in this section shall comply with Section J2.1.
2. All other *HVAC* *systems* shall comply with one of the following:
   1. The applicable requirements in Section 6.5 or
   2. *HVAC systems* that only serve the heating, cooling, or ventilating needs of a *computer room* with IT *equipment* load greater than 10 *kW* shall be permitted to comply with ASHRAE Standard 90.4, *Energy Standard for Data Centers*.

**J1.1.1 Allowable HVAC Systems**

*HVAC* *systems* are allowed to use the Mechanical *System* Performance Rating Method if they comply with all the following criteria:

1. The *HVAC* *system* type is included in Table J1.1.1
2. The *HVAC* *system* serves a *building* use type included in Section J1.1.2
3. The *HVAC* *system* is not excluded by Section J1.1.3
4. The *HVAC* *system* is powered by grid-delivered electricity, renewable electricity, natural gas, propane, renewable thermal *energy*, distillate fuel oil or district energy.

**Informative note:**

The intention of the scope is to allow using the *Mechanical System* Performance Rating Method for most of the building with HVAC *systems* excluded from the scope complying using either the prescriptive path or the *computer room* *system* path.

**Table J1.1.1: Proposed Building HVAC Systems Allowed to use the Mechanical System Performance Rating Method**

|  |  |
| --- | --- |
| *System* No. | *System* Name |
| 1 | *Packaged Terminal Air Conditioner* (with electric or hydronic heat) |
| 2 | *Packaged Terminal* Heat pump |
| 3 | Packaged Single Zone Furnacea and/or air cooled Air Conditioner (includes split systemsb) |
| 4 | Packaged Single Zone Heat Pump (air to air only) (includes split systemsb and electric or gas supplemental heat) |
| 5 | *Variable-Refrigerant-Flow-System* (air source) |
| 6 | Four-Pipe Fan Coil |
| 7 | Water-Source Heat Pump (Water Loop), Water-Source *Variable-Refrigerant-Flow-System*, or Water-Source Air Conditioner |
| 8 | Ground-Source Heat Pump |
| 9 | Packaged *Variable-air-volume system* (DX cooling) with reheata |
| 10 | *Variable-air-volume system* (hydronic cooling) with reheata |
| 11 | *Variable-air-volume system* with Fan Powered Terminal Units |
| 12 | Dedicated *Outdoor air* *System* (in conjunction with *systems* 1-8) |
| 13 | Hot Water or Electric Baseboards (in conjunction with systems 9-11) |  |
| 14 | District Heating *System* (in conjunction with systems 1, 6, 9, 10 and 11) |
| ~~15~~ | ~~District Cooling~~ *~~System~~* ~~(in conjunction with systems 6, 10 and 11)~~ |

Notes

1. Reheat or primary heat may be electric, hydronic, or gas furnace
2. When using Section 2.1.4 “Modeling-Based Path”, condensing units with DX air handlers shall be modeled as package furnace with air conditioners or heat pumps

**Informative note**

The allowed *system* types may not be supported by all simulation program versions. The simulation program is required to support the reference *systems* for the *building* types modeled and the proposed *system* type(s) ~~must be supported by the~~ *~~simulation program~~*~~.~~

**J1.1.2 Allowable Building Use Types**

*HVAC* *systems* that serve the following *building* use types are allowed to use the Mechanical *System* Performance Rating Method:

1. large office (*gross conditioned floor area* >150,000 ft2 or > 5 floors)
2. medium office (*gross conditioned floor area* 5000 to 150,000 ft2 and ≤ 5 floors)
3. small office (*gross conditioned floor area* ≤5000 ft2 and ≤ 5 floors)
4. retail
5. multifamily (including dormitory)
6. hotel (including motel)
7. school (including education and university)
8. Other *building* use types that are <1000 ft2 and <10% of the *building* conditioned floor area unless specifically excluded by Section J1.1.3(a)

**Informative note**

Item h allows for a small sandwich or coffee counter service area but not a restaurant in an office *building* lobby or bookstore for example.

**J1.1.3 Excluded HVAC Systems**

The following *HVAC* *systems* are excluded from using the Mechanical *System* Performance Rating Method:

1. *HVAC* *systems* serving one of the following excluded *building* areas:
   1. Data centers and *computer rooms* with *equipment* power density exceeding 20 W/ft2 of conditioned floor area and exceeding 10 *kW* of *equipment* load
   2. Laboratories with fume hoods
   3. Locker rooms with more than 4 showers
   4. Cafeterias and dining rooms
   5. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h (does not include break rooms)
   6. Natatoriums or rooms with saunas
   7. Areas of *buildings* with commercial refrigeration *equipment* exceeding 100 *kW* of power input
2. *HVAC systems* that are not replaced in their entirety as part of an *Alteration* and are not serving initial build-out construction
3. *HVAC* *systems* serving *portions* of the *building* that are also served in parallel by other *HVAC* *systems* not allowed to use the Mechanical *System* Performance Rating Method
4. small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or
5. double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
6. *packaged terminal air conditioners* and *packaged terminal heat pumps* that have cooling capacity greater than 12,000 Btu/hr
7. Systems with a common heating source serving both HVAC and *service water heating* *equipment*, or
8. *HVAC systems* that provide recovered heat for *service water heating*
9. *HVAC systems* using district cooling*.*

**Exceptions to J1.1.3(a and c)**

1. Multiple zone *HVAC* *systems* in Table J1.1.1, including dedicated *outdoor air* *systems*, where 80% or more of *system* supply air serves allowed *building* use types in accordance with Section J1.1.2 and 20% or less of *system* supply air serves excluded areas in Section J1.1.3 (a) or (c).

2. Central chiller or *boiler* plants where 80% or more of capacity serves allowed *building* use types in accordance with Section J1.1.2 and 20% or less of capacity serves excluded areas in Section J1.1.3(a) or (c).

**J2 Mechanical System Performance Rating Method**

**J2.1** **Compliance**

**J2.1.1 Mandatory Requirements**

All *HVAC* *systems* in the proposed *building* design shall comply with the requirements in Section 6.2.1.

**Informative note:**

*Buildings* using the Mechanical *System* Performance Rating Method are required to meet all mandatory provisions in Section 6.4 in accordance with 6.2.1. For example, while *DCV* controlled area in the proposed *building* is one of the user entries in the simulation program, the minimum entry needs to meet the floor area where *DCV* is required in accordance with Section 6.4.3.8. The intent of this entry is to give credit for *DCV* control in more area than required, but not to allow *DCV* that is a mandatory requirement to be traded off with other *efficiency* improvements.

**J2.1.2 Additional Requirements**

1. *HVAC* *systems* meeting requirements of Section J1.1 shall comply with either Section J2.1.3 “Prescriptive Compliance Path” or Section J2.1.4 “Modeling-Based Path”.
2. Compliance documentation and supplemental information shall be submitted in accordance with Sections 4.2.2. For the modeling-based path in Section J2.1.4, additional documentation shall be submitted as required in Section J2.1.4.5.

**J2.1.3 Prescriptive Compliance Path**

*Systems* in the *proposed design* shall meet Section 6.5 "Prescriptive Compliance Path” and the following additional requirements:

**J2.1.3.1 Space Conditioning System Type**

HVAC systems of the following types are allowed:

1. Packaged air- source Heat Pump with supplemental electric resistance heating ~~available below~~ locked out above 40°F
2. Variable Refrigerant flow Heat Pump air cooled, water cooled, groundwater or ground source
3. Ground Source and Groundwater Source Heat Pump
4. Water-source Heat Pump is only permitted for offices 50,000 SF or greater and multifamily over 10 floors

The HVAC *systems* shall use electricity for space heating and cooling

**J2.1.3.2 Mechanical Ventilation**

1. Ventilation outdoor airflow shall be supplied ~~and exhausted~~ through a Dedicated Outdoor Air System (DOAS) equipped with a supply fan, exhaust fan, and ~~a heat~~ an energy recovery device. No additional ~~heating or~~ cooling shall be provided by the DOAS. DOAS temperature control shall be as specified in Table J2.1.3.
2. The DOAS supply and return fans shall run whenever ~~the HVAC~~ *~~system~~* ~~is scheduled to operate.~~ one or more spaces served by the system are scheduled to be occupied and shall not require operation of the space conditioning system fans for ventilation air delivery.
3. ~~DOAS temperature control shall be as specified in Table J2.1.3.1.~~
4. The DOAS system energy recovery device shall have a*n enthalpy recovery ratio* of at least 60% at cooling and heating design conditions.

**J2.1.3.3 Fan System Power**

Fan *system* power shall not exceed allowances ~~be as specified~~ in Table J2.1.3

1. Space conditioning *system* fans shall cycle on to meet heating and cooling setpoints ~~schedules~~ and shall not run continuously. ~~Conditioning~~ *~~system~~* ~~fan operation is not necessary for ventilation delivery.~~
2. Where sound attenuation section is specified in the *proposed design* for fans ~~service~~ serving spaces with design background noise goals below NC35*,* ~~space conditioning~~fan powerallowance shall be increased ~~by 3.5%~~ based on the pressure drop adjustment in Table 6.5.3.1-2.
3. For systems in the *proposed design* with specified particulate filtration of MERV 13 or greater, fan power allowance in Table J2.1.3 shall be increased based on the pressure drop adjustment in Table 6.5.3.1-2.

**J2.1.3.4 Air-side economizers** shall be included ~~in all building types except multifamily.~~ where required in Section 6.5.1 excluding Exception 1.

**Exceptions to J2.1.3.4**

* 1. Water-source heat pump *systems*
  2. HVAC *systems* serving *dwelling units*

**J2.1.3.5 Additional Requirements for Water Source Heat Pumps**

1. Heat rejection shall be provided by a cooling tower with variable-speed fans designed to supply no less than 40.2 gpm per/hp.
2. Pump motor input power shall not exceed 22 W/gpm.
3. Loop flow shall be variable with variable speed drive pump and unit fluid flow shutoff at each heat pump when its compressor cycles off.

**Table J2.1.3 - *Additional HVAC System Requirements***

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter | Building Type | | | | | | |  | |  | |
| Office 50,000SF or greater | Office less than 50,000SF | | Retail | | School/  Education | | Multifamily  >10 floors | | Multifamily, 4-10 floors, hotel/Motel | |
| Space conditioning fan power allowance (W/cfm) ~~proposed~~ <MERV13 | ~~0.585~~ 0.528 | 0.528 | | ~~0.585~~ 0.522 | | ~~0.585~~ 0.528 | | 0.528 | | 0.528 | |
| ~~Space conditioning fan power (W/cfm) proposed ≥MERV13~~ | ~~0.703~~ | ~~0.634~~ | | ~~0.703~~ | | ~~0.703~~ | | ~~0.634~~ | | ~~0.634~~ | |
| DOAS Fan Power allowance (W/cfm of outside air) ~~proposed~~ <MERV13 | ~~0.838~~ 0.819 | ~~0.838~~ 0.819 | | ~~0.819~~ 0.730 | | ~~0.819~~ 0.742 | | ~~0.819~~ 0.730 | | ~~0.819~~ 0.730 | |
| ~~DOAS fan power (W/cfm) proposed ≥MERV13~~ | ~~1.066~~ | ~~1.066~~ | | ~~1.042~~ | | ~~1.042~~ | | ~~1.042~~ | | ~~1.042~~ | |
| DOAS temperature control (Note 1) | Bypass | Wild | | Bypass | | Bypass | | Bypass | | Wild | |
|  |  |  |  | |  | |  | |  | |  | |

Note 1: DOAS temperature control legend

1. “Wild” DOAS control indicates no active control of the supply air temperature leaving the DOAS *system*. Temperature will fluctuate based only on entering and leaving conditions and the effectiveness of ERV.
2. “Bypass” DOAS control includes modulating dampers to bypass ERV with the intent to maintain supply air temperature at a maximum of 60 deg. F. when outside air is below 75°F. Once outside air is above 75°F bypass dampers will be fully closed.

~~HVAC~~ *~~systems~~* ~~shall comply with Section J2.1.4.1, Partial Prescriptive Requirements, Section J2.1.4.2 Total System Performance Ratio Compliance Criteria, Section 4.1.4.3 TSPR Calculations and Section 2.1.4.4 Additional Modeling Requirements.~~

**J2.1.4 Modeling-Based Compliance Path**

HVAC *systems* shall comply with Section J2.1.4.1 “Partial Prescriptive Requirements”, Section J2.1.4.2 “~~TSPR~~ Compliance Criteria”, Section J~~4~~2.1.4.3 “~~TSPR Calculations~~ Calculating TSPR” and Section J2.1.4.4 “Additional Modeling Requirements”.

**J2.1.4.1 Partial Prescriptive Requirements**

*HVAC* *systems* using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section 6.5 as follows:

1. Air *economizers* shall meet the requirements of Section 6.5.1.1.5 “relief of excess *outdoor air*” and Section 6.5.1.1.6 “sensor accuracy.”
2. Steam humidifiers shall meet requirements of Section 6.5.2.4.
3. *Variable-air-volume system* *systems* shall meet requirements of Sections 6.5.3.2.2, 6.5.3.2.3, and 6.5.3.3.
4. Hydronic *systems* shall meet the requirements of 6.5.4.2.
5. Plants with multiple chillers or *boiler*s shall meet the requirements of Section 6.5.4.3.
6. Chilled water and heating water supply temperature reset shall meet the requirements of Section 6.5.4.4 without exception.
7. Hydronic (Water Loop) Heat Pumps and Water-Cooled *Unitary Air Conditioners* shall meet the requirements of Section 6.5.4.5.
8. Cooling tower turndown shall meet requirements of Section 6.5.5.4.
9. Heating of unenclosed *spaces* shall meet the requirements of Section 6.5.8.1.
10. Hot-gas bypass shall meet the requirements of Section 6.5.9.
11. *Systems* shall meet the door switch *control* requirements of Section 6.5.10.
12. Refrigeration *systems* shall meet the requirements of Section 6.5.11.

~~Packaged Air- source Heat Pump with supplemental electric resistance heating available below 40°F~~

1. ~~Variable Refrigerant flow Heat Pump air cooled, water, groundwater or ground source~~
2. ~~Ground Source or Groundwater Source Heat Pump~~
3. ~~Water-source Heat Pump is permitted for offices 50,000 SF or greater and multifamily over 10 floors~~

**~~J2.1.3.2 Mechanical Ventilation~~**

1. ~~Ventilation air shall be supplied and exhausted through a Dedicated Outdoor Air System (DOAS) equipped with a supply fan, exhaust fan, and exhaust air heat recovery. No additional heating or cooling shall be provided by the DOAS.~~
2. ~~The DOAS supply and return fans shall run whenever the HVAC~~ *~~system~~* ~~is scheduled to operate and shut off during unoccupied hours.~~
3. ~~DOAS temperature control shall be as specified in Table J2.1.3 and as described below.~~
4. ~~“Wild” DOAS control indicates no active control of the supply air temperature leaving the DOAS~~ *~~system~~*~~. Temperature will fluctuate based only on entering and leaving conditions and the effectiveness of ERV.~~
5. ~~“Bypass” DOAS control includes modulating dampers to bypass ERV with the intent to maintain supply air temperature at a maximum of 60 deg. F. when outside air is below 75°F. Once outside air is above 75°F bypass dampers will be fully closed.~~

**~~J2.1.3.3 Fan System Power~~**

~~Fan system power shall be as specified in Table J2.1.3~~

~~Space conditioning~~ *~~system~~* ~~shall cycle on to meet heating and cooling setpoint schedules. Conditioning~~ *~~system~~* ~~fan operation is not necessary for ventilation delivery.~~

~~Where sound attenuation section is specified in the~~ *~~proposed design~~* ~~for fans service spaces with design background noise goals~~~~below NC35~~*~~,~~* ~~space conditioning~~~~fan power~~~~allowance is permitted to be increased by 3.5%.~~

**~~J2.1.3.4~~** ~~Air-side economizers shall be included in all building types except multifamily~~

**~~J2.1.3.5 Additional Requirements for Water Source Heat Pumps~~**

1. ~~Heat rejection shall be provided by a single axial fan cooling tower with variable-speed fans designed to supply no less than 40.2 gpm per/hp, sized for an approach of 10°F and a range of 10°F.~~
2. ~~Heat source shall be gas or electric resistance boiler~~
3. ~~Pump motor input power shall not exceed 16 22 W/gpm.~~
4. ~~Loop flow shall be variable with variable speed drive pump and unit fluid flow shutoff at each heat pump when its compressor cycles off.~~

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ~~Parameter~~ | ~~Building Type~~ | | | | | | |
| ~~Office 50,000SF or greater~~ | ~~Office less than 50,000SF~~ | ~~Retail~~ | ~~School/Education~~ | ~~Multifamily~~  ~~>10 floors~~ | ~~Multifamily, 4-10 floors, hotel/Motel~~ |
| ~~Space conditioning fan power (W/cfm) proposed <MERV13~~ | ~~0.585~~ | ~~0.528~~ | ~~0.585~~ | ~~0.585~~ | ~~0.528~~ | ~~0.528~~ |
| ~~Space conditioning fan power~~~~(W/cfm) proposed ≥MERV13~~ | ~~0.703~~ | ~~0.634~~ | ~~0.703~~ | ~~0.703~~ | ~~0.634~~ | ~~0.634~~ |
| ~~DOAS Fan Power~~  ~~(W/cfm of outside air) proposed <MERV13~~ | ~~0.838~~ | ~~0.838~~ | ~~0.819~~ | ~~0.819~~ | ~~0.819~~ | ~~0.819~~ |
| ~~DOAS fan power (W/cfm) proposed ≥MERV13~~ | ~~1.066~~ | ~~1.066~~ | ~~1.042~~ | ~~1.042~~ | ~~1.042~~ | ~~1.042~~ |
| ~~DOAS temperature control1~~ | ~~Bypass~~ | ~~Wild~~ | ~~Bypass~~ | ~~Bypass~~ | ~~Bypass~~ | ~~Wild~~ |

**~~Table J2.1.3 -~~ *~~Additional HVAC System Requirements~~***

~~HVAC~~ *~~systems~~* ~~shall comply with Section J2.1.4.1, Partial Prescriptive Requirements, Section J2.1.4.2 Total System Performance Ratio Compliance Criteria, Section 4J2.1.4.3 Calculating TSPR Calculations and Section J2.1.4.4 Additional Modeling Requirements.~~

**~~J2.1.4.1 Partial Prescriptive Requirements~~**

*~~HVAC~~**~~systems~~* ~~using the modeling-based compliance path shall meet the following requirements:~~

1. ~~Air~~ *~~economizers~~* ~~shall meet the requirements of Section 6.5.1.1.5 “relief of excess~~ *~~outdoor air~~*~~” and Section 6.5.1.1.6 “sensor accuracy.”~~
2. ~~Steam humidifiers shall meet requirements of Section 6.5.2.4.~~
3. *~~Variable-air-volume system~~**~~systems~~* ~~shall meet requirements of Sections 6.5.3.2.2, 6.5.3.2.3, and 6.5.3.3.~~
4. ~~Hydronic~~ *~~systems~~* ~~shall meet the requirements of 6.5.4.2.~~
5. ~~Plants with multiple chillers or~~ *~~boiler~~*~~s shall meet the requirements of Section 6.5.4.3.~~
6. ~~Chilled water and heating water supply temperature reset shall meet the requirements of Section 6.5.4.4 without exception.~~
7. ~~Hydronic (Water Loop) Heat Pumps and Water-Cooled~~ *~~Unitary Air Conditioners~~* ~~shall meet the requirements of Section 6.5.4.5.~~
8. ~~Cooling tower turndown shall meet requirements of Section 6.5.5.4.~~
9. ~~Heating of unenclosed~~ *~~spaces~~* ~~shall meet the requirements of Section 6.5.8.1.~~
10. ~~Hot-gas bypass shall meet the requirements of Section 6.5.9.~~
11. *~~Systems~~* ~~shall meet the door switch~~ *~~control~~* ~~requirements of Section 6.5.10.~~
12. ~~Refrigeration~~ *~~systems~~* ~~shall meet the requirements of Section 6.5.11.~~

**J2.1.4.2 *~~Total System Performance Ratio~~* ~~(TSPR) Modeling-Based~~ Compliance Criteria** The *proposed design* *Total System Performance Ratio* (*TSPR*p) of the *HVAC* *systems* using this method shall be greater than or equal to the *Total System Performance Ratio* of the *TSPR reference building design* (*TSPR*r) divided by the mechanical performance factor (MPF) when calculated in accordance with the following:

*~~TSPR~~*~~p~~ ~~>~~ *~~TSPR~~*~~r~~ ~~/ MPF~~

**~~J2.1.4.2 TSPR Compliance Criteria~~**

~~The~~ *~~proposed design~~**~~Total System Performance Ratio~~* ~~(~~*~~TSPR~~*~~p~~~~) of the~~ *~~HVAC~~**~~systems~~* ~~using this method shall be greater than or equal to the~~ *~~Total System Performance Ratio~~* ~~of the~~ *~~TSPR reference building design~~* ~~(~~*~~TSPR~~*~~r~~~~) divided by the (MPF) when calculated in accordance with the following:~~

*TSPR*p > *TSPR*r / MPF

Where:

*TSPR*p= *Proposed* *TSPR* calculated in accordance with Section J2.1.~~5~~ 4.3 “Calculating *TSPR*” and the requirements of Sections J2, J3, J4

*TSPR*r *=* *Reference TSPR* calculated in accordance with Section J2.1.~~5~~ 4.3 “Calculating *TSPR*” and the requirements of Sections J2, J3 and J4.

MPF = Mechanical Performance Factor from Table J2.1.~~2~~.4.2 based on climate zone and *building* use type

Where a *building* has multiple *building* use types, MPF shall be area weighted as follows:

MPF = ( A1 \* MPF1 + A2 \* MPF2 + . . .+ An \* MPFn) / (A1 + A2 + . . .+ An)

Where:

MPF1, MPF2 through MPFn = Mechanical performance factors from table ~~J2.1.2.2~~ J2.1.4.2 based on climate zone and*building* use types 1,2, through n

A1,  A2 through An = Conditioned *floor* areasfor *building* use types 1, 2, through n

**Informative note:**

The Mechanical *System* Performance Rating Method is a simplified performance trade-off approach for *HVAC* *systems* that does not require using the whole *building* trade-off approaches in Appendix G. *HVAC* *systems* that are allowed to use this approach will not need to comply with all of the prescriptive requirements in Section 6.5. For example, an *HVAC* *system* without a required outside air economizer can show compliance with Section 6 by demonstrating improved cooling *efficiency* or reduced fan *energy* use compared to a reference *HVAC* *system* that meets all prescriptive requirements, including outside air economizers. This approach does not allow *HVAC* *system* *efficiency* trade-offs with *building envelope,* plug loads*,* or lighting *systems*.

**Table J2.1.4.2 Mechanical Performance Factors (MPF), Site Energy Basis**

|  |  |  |  |
| --- | --- | --- | --- |
| Climate Zone:  *Building* type | 4A | 5A | 6A |
| Office (small and medium)a | TBD | TBD | TBD |
| Office (Large)a | TBD | TBD | TBD |
| Retail | TBD | TBD | TBD |
| Hotel/Motel | TBD | TBD | TBD |
| Multi-Family/ Dormitory | TBD | TBD | TBD |
| School/ Education | TBD | TBD | TBD |

a Office sizes defined in Section J1.1.2.

**Note to reviewers:** MPF will be determined based on the parameters of the target system meeting requirements in Section J2.1.2. For multifamily over 10 stories high and large offices the space conditioning system type will be WSHP ~~with 80% efficient gas atmospheric~~ electric resistance boiler. For all other building types space conditioning system will be air-source heat pump.

**J2.1.4.3** **Calculating TSPR**

*TSPR*p shall be calculated according to Equation J1:

*TSPR*p = ( J1)

Where:

Loadsr = Sum of the annual heating and cooling loads for the *TSPR reference building design* met by the *building* *HVAC* *system*, in thousand Btu

HVACinputP = Sum of the annual *energy* input for heating, cooling, fans, *energy* recovery, *pump*s, and heat rejection for the *proposed design*. The HVAC *energy* input units shall be in accordance with Section J4.

*TSPR*r shall be calculated according to Equation J2:

*TSPR*r = ( J2)

Where:

Loadsr = Sum of the annual heating and cooling loads for the *TSPR reference building design* met by the *building* *HVAC* *system,* in thousand Btu (kWh).

HVACinputr = Sum of the annual HVAC *energy* input for heating, cooling, fans, *energy* recovery, *pump*s, and heat rejection for the *TSPR reference building design.* The HVAC *energy* input units shall be in accordance with Section J4.

**Informative note:**

The annual HVAC *energy* uses calculated using the Mechanical *System* Performance Rating Method are not predictions of whole *building* *energy* consumption for an actual proposed *building* after construction. Actual experience will differ from these calculations due to variations such as occupancy, *building* operation and maintenance, weather, *energy* use of *systems* and *building* areas not covered by this procedure, and the precision of the calculation tool.

**J2.1.4.4 Additional Modeling Requirements**

***J2.1.4.4.1 Alterations***

*Alterations* that include replacement of the entire *HVAC* *system* shall be treated as a new *building*.

**J2.1.4.4.2 Core & Shell and Initial Build-Out Construction**

Where the *building* permit applies to only a portion of the *HVAC* *system* in a *building* and the remaining components will be designed under a future *building* permit or were previously installed, the future or previously installed components shall be modeled as follows:

1. Where the *HVAC zones* that do not include *HVAC* *systems* in the current permit will be or are served by independent *systems*, then the block (See Section J2.2.1) including those zones shall not be included in the model.
2. Where the *HVAC zones* that do not include complete *HVAC* *systems* in the permit are intended to receive HVAC services from *systems* in the permit, their proposed zonal *systems* shall be modeled with identical *equipment* that meets, but does not exceed, the requirements of Section 6.4 and Section 6.5.
3. Where the zone *equipment* in the permit receives HVAC services from previously installed *systems* that are not in the permit, the previously installed *systems* shall be modeled with identical *equipment* matching the certified value of what is installed or *equipment* that meets the requirements of Section 6.4 and Section 6.5, whichever has the more efficient *energy* use.
4. Where the central plant heating and cooling *equipment* is completely replaced and *HVAC zones* with *existing* *systems* receive HVAC services from *systems* in the permit, their proposed zonal *systems* shall be modeled with *equipment* that meets, but does not exceed, the requirements of Section 6.4 and Section 6.5.

**Informative Notes:**

1. Examples of *HVAC* *systems* that are intended to receive HVAC services from *systems* in the permit include future zonal water source heat pumps that will receive loop water that is heated by a *boiler* or cooled by a cooling tower included in the permit, any *system* that will receive outdoor *ventilation* air from a dedicated *outdoor air* *system* included in the permit, and future zone terminal units that will be connected to a central *VAV* *system* included in the permit.

2. An initial build-out with heating coils served from a previously installed *system* with a high-*efficiency* condensing *boiler* would use the installed *efficiency* if it exceeded the current requirements. If the installed *boiler* had a lower *efficiency* than the current requirements, the current requirement would be used.

3. A partial central plant upgrade (e.g. chiller, but not *boiler* replacement) cannot use this method.

**J2.1.4.5 Additional Submittal Requirements**

Where *TSPR*p and *TSPR*r are used to demonstrate compliance in accordance with the Normative Appendix J, documentation shall be provided to the *building official* including the following:

1. A compliance report as outlined in Section J3.4 generated by the *simulation program.*
2. A mapping of the actual *building* HVAC component characteristics and those simulated in the *proposed design* showing how individual pieces of HVAC *equipment* identified above have been combined into average inputs as required by the *simulation program* including, but not limited to:
3. Fan
4. Hydronic *pump*s
5. Air handlers
6. Packaged cooling *equipment*
7. Furnaces
8. Heat pumps
9. *Boiler*s
10. Chillers
11. Heat rejection equipment (open and closed circuit cooling towers; dry coolers)
12. *Electric resistance* coils
13. Condensing units
14. Motors for fans and *pump*s
15. *Energy* recovery devices
16. For each piece of *equipment* identified in J2.1.~~6~~4.5(b) above include the following along with the units specified in Table J2.2.3 as applicable:
17. *Equipment* name or tag consistent with that found on the design documents.
18. Rated *Efficiency* level, full load efficiency as rated in Section 6.8.
19. Rated Capacity.
20. Where not provided by the *simulation program* report in item a, documentation of the calculation of any weighted equipment efficiencies input into the program.
21. Electrical input power for fans and *pump*s (before any speed or frequency *control device*) at design condition and calculation of input value (W/cfm or W/gpm)

d. A floor plan of the *building* identifying how portions of the *building* are assigned to the simulated blocks (See Section J2.2.1) and which areas of the *building* are served by *HVAC* *systems* meeting requirements of Section J1.1 “Scope”.

**Informative Note:**

The items listed under b and c above may either be included in the report generated by the *simulation program* or may be submitted separately. The compliance report required by Section J3.4 includes the composite *systems* entered into the program for the blocks. These may differ from actual *systems* and may be based on capacity *efficiency* weighting per Section J2.2.3.1. The *simulation program* may allow input of individual actual *systems* and perform the weighting, or it may require the user to perform that weighting separately and input the weighted *efficiencies*. In the second case, the weighted *efficiency* calculation would be included under c here.

**J2.2 Proposed Building Information Required**

The simulation of *HVAC* *systems* and the *HVAC zones* they serve shall be modeled based on *building* information required by this Section.

**J2.2.1 Simplified Block Approach**

The geometry of *buildings* shall be configured using one or more simplified geometric simulation *building* blocks, referred to as “blocks” in this appendix. Each block contains one or multiple *thermal blocks*. A more complex zoning of the building shall be allowed where all thermal *zones* in the reference and proposed model are the same and rules related to block geometry and *HVAC system* assignment to blocks are met with appropriate assignment to thermal *zones*.

**J2.2.1.1 Block Geometry**

Each block shall define attributes including block dimensions, number of *floors*, *floor* to *floor* height and *floor* to ceiling height. The *simulation program* is permitted to allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent blocks. Where actual *building* shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The *conditioned floor area* and volume of each block shall match the actual *proposed design* within 10%.
2. The area of each *exterior building envelope* component from Tables 5.5-1 through 5.5-8 is accounted for within 10% of the actual *proposed design*.
3. The area of vertical *fenestration* and *skylights* is accounted for within 10% of the actual *proposed design*.
4. The *orientation* of each component in b and c above is accounted for within 45° of the actual *proposed design*.

The user shall create multiple blocksif necessary, to meet these requirements.

**J2.2.1.2 Number of Blocks**

One or more blocksshall be created per *building* based on the following restrictions:

1. Each block shall have only one *building* use type. At least one single block shall be created for each unique use type, including where one *HVAC* *system* serves two different use types.
2. Each block shall be served by only one type of primary or zonal *HVAC* *system*. A DOAS *system* shall be permitted to serve blocks served by other *systems*. A single block shall be created for each unique primary or zonal *HVAC* *system* type and *building* use type combination. Multiple HVAC units of the same type are permitted to be represented in one block in accordance with Section J2.2.3.1.
3. Each block shall have a single definition of *floor* to *floor* or *floor* to ceiling heights. Where *floor* heights differ by more than two ft, unique blocks shall be created for the floors with varying heights.
4. Each block can include either above-*grade* or below-*grade* exterior *floors*. For *buildings* with both above-*grade* and below-*grade* *floors*, separate blocks shall be created for each. For *buildings* with *floors* partially above-*grade* and partially below-*grade*, if the total *wall* area of the floor(s) in consideration is greater than or equal to 50% above-*grade*, then it shall be simulated as a completely above-*grade* block, otherwise it shall be simulated as a below-*grade* block.
5. In order to combine multiple *floors* into a single block, each *wall* on a façade of a block shall have similar *vertical fenestration area*. The product of the *proposed design* *U-factor* times the area of vertical *fenestration* (UAVerFen) on each façade of a given floor cannot differ by more than 15% of the average UAVerFen for that façade in each block. The product of the *proposed design* *SHGC* times the area of vertical *fenestration* (*SHGC*AVerFen) on each façade of a given floor cannot differ by more than 15% of the average *SHGC*AVerFen for that façade in each block. If these conditions are not met, additional blocks shall be created consisting of *floors* with similar *fenestration*.
6. For a *building* model with multiple blocks, each block façade input shall provide adequate information to identify the outside boundary condition (outside, inside to adjacent block, ground contact, or adiabatic) of each façade or portion of each façade that match the actual *proposed design*.

**Informative Note:**

The *simulation program* may automatically identify the adjacent block façade outside boundary conditions through a graphic input process.

**J2.2.2 Building Envelope Components**

*Building envelope* thermal properties used in the *proposed design* shall be based on the actual *proposed design* using documented user-defined values and shall comply with all of the following:

1. Where different *roof* thermal properties are present in a single block, an area-weighted *U-factor* shall be used.
2. Where different *wall* constructions exist on the façade of a blockan area-weighted *U-factor* shall be used.
3. Where different *below-grade wall* constructions exist in a block, an area-weighted *C- factor* shall be used.
4. Where different *floor* constructions exist in the blockan area-weighted *U-factor* shall be used.
5. Where different *slab-on-grade floor* constructions exist in a block, an area-weighted *F-factor* shall be used.
6. Where different vertical *fenestration* types or sill heights exist, area-weighted sill heights, *U-factor* and *SHGC* values shall be used.
7. Where different *skylight* types exist, area-weighted *U-factor* and *SHGC* values shall be used.
8. Permanent shading devices such as overhangs shall be modeled only if >50% of the area of vertical *fenestration* on a façade is shaded by the same.

**J2.2.3 HVAC System Components**

The *HVAC* *system* parameters shall be provided for the *proposed design* at *design conditions* unless otherwise stated with clarifications and simplifications as described in Table J2.2.3 and as follows:

1. All *HVAC zones* within a blockshall be served by the same *HVAC* *system* type as listed in Table J1.1.1.
2. Where multiple *system* components serve a block, average values weighed by the appropriate metric as described in Section J2.2.3.1 shall be used.
3. The Table J2.2.3 parameter requirements are based on input of full-load *equipment efficiencies* with adjustment using part-load curves integrated in the simulation program. Where other approaches to part-load adjustment are used, it is permitted for specific input parameters to vary.

**Informative Note:**

Table J2.2.3 includes both user-defined parameters and parameters that are fixed in the *simulation program* and may not be changed by the user. They are maintained in one table here so related items are together.

**Table J2.2.3: Proposed Building HVAC System Parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Parameter** | **Fixed or User Defined** | **Required** | **Applicable Systems** a |
| *HVAC* *System* Type | *System* Type | User-defined | Selected from Table J1.1.1 | All |
| *System* Sizing | Design Day Information | Fixed | 99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design | All |
| Zone Coil Capacity | Fixed | Sizing factors used are 1.25 for heating *equipment* and 1.15 for cooling *equipment* | All |
| Supply Airflow | Fixed | Based on the greater of a supply-air-to-room-air temperature *set point* difference of 20°F (11°C) or required *outdoor air* *ventilation* |  |
| Outdoor *Ventilation* Air and Filtration | Portion of supply air with proposed Filter ≥MERV 13 | User-defined | Percentage of supply air flow subject to higher filtration (Adjusts Reference Fan Power higher. prorated) | All |
| Outdoor *Ventilation* Supply Air Flow Rate Adjustments | Fixed | Basis is 1.0 Zone Air Distribution Effectiveness | All |
| Outdoor *Ventilation* Supply Air Flow Rate | Fixed | As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed *DCV* *control* (see separate item below) | All |
| *System* Operation | *Space* Temperature *Set Points* | Fixed | As specified in ASHRAE Standard 90.1 Normative Appendix C with the exception of hotel/motel that shall be 70°F (21°C) heating 72°F (22°C) cooling | All |
| Fan Operation – Occupied (where DOAS meets *ventilation* requirements) | User-defined | Fan either 1) runs continuously during occupied hours or 2) is cycled to meet thermal load | All (Continuous)  1-11 (Cycles) |
| Fan Operation – Occupied (where heating and cooling units provide *ventilation* – No DOAS) | Fixed | Fan runs continuously during occupied hours; *VAV* or multi-speed fans reduce airflow related to thermal load | 1-11 |
| Fan Operation -Night Cycle | Fixed | Fan cycles on to meet *setback* temperatures | 1-11 |
| Packaged *Equipment* *Efficiency* | DX Cooling *Efficiency* | User-defined | Cooling *COP* without fan *energy* calculated in accordance with Section J4.2.3(d). | 1, 2, 3, 4, 5, 7, 8, 9, 11, 12 |
| DX Coil Number of Stages | User-defined | Single Stage or Multistage | 3,4,9,10,11,12 |
| Heat Pump *Efficiency* | User-defined | Heating *COP* without fan *energy* calculated in accordance with Section J4.2.3(d). | 2,4,5,7,8,12 |
| Furnace *Efficiency* | User-defined | Furnace thermal *efficiency* | 1,3,9,12 |
| Heat Pump Supplemental Heat | Heat Source | User-defined | Electric Resistance or gas furnace | 2,4,7,8,12 |
| Control | Fixed | Electric resistance heat locked out above 40°F OAT. Runs as needed In conjunction with compressor between 40°F and 0°F. Gas heat operates in place of the heat pump when the heat pump cannot meet load. | 2,4,7,8,12 |
| *System* Fan Power and control | Design Fan Power (W/cfm) (W∙s/L) | User-defined | Input electric power for all fans required to operate at *fan system design conditions* divided by the supply airflow rate. Include any VSD losses at design condition. This is a “wire to air” value including all drive, motor *efficiency* and other losses. | All |
| Part-load Fan Controls:  -Constant volume  -Two Speed or 3 three speed, then input:  W/cfm (W∙s/L) at each speed  % cfm (% L/s) at leach speed  -*VAV* | User-defined | Static pressure reset included for *VAV*. | All (Constant Volume, Two Speed)  9,10.11 (VAV) |
| *Variable-air-volume system* *Systems* | Supply Air Temperature Controls (select):  -None  -OAT SAT reset  -Warmest zone SAT reset | User-defined | If not SAT reset then constant at 55°F (12.8°C).  Options for reset based on OAT or warmest Zone.  If OAT reset, SAT is reset higher to 60°F (15.6°C) at outdoor low of 50°F (10°C). SAT is 55°F (12.8°C) at outdoor high of 70°F (21.1°C).  If warmest zone, then the user can specify the minimum and maximum temperatures. | 9,10,11 |
| Zone minimum damper & Evs  62.1 simple method  except for Schools | Fixed | Schools: Zone minimum = 1.2 \* Voz minimum design *ventilation* rate; Evs = 0.65  Other *buildings*:  Simple 62.1 method is 1.5 \* Voz cfm zone minimum  design *ventilation* rate; Evs = 0.75 | 9,10,11 |
| Dual *set point* minimum *VAV* damper position | User-defined | Heating minimum and maximum airflow fraction | 9,10,11 |
| Terminal Unit Heating Source | User-defined | Electric or hydronic |  |
| Fan Powered Terminal Unit Type | User-defined | Series or parallel FPTU | 11 |
| Parallel FPTU Fan |  | Sized for 50% peak primary air at 0.35 W/cfm (0.74 W∙s/L) | 11 |
| Series FPTU Fan | Fixed | Sized for 50% peak primary air at 0.35 W/cfm (0.74 W∙s/L) | 11 |
| Economizer | OSA Economizer Presence | User-defined | Yes or No | 3,4,5,6,9,10,11 |
| Economizer High Limit | Fixed | Lockout on Differential dry-bulb temperature (OAT > RAT) in 6A, 5A; fixed enthalpy >28 Btu/lb or fixed drybulb OAT *>* 75°F in 4A climate zone |  |
| *Energy* Recovery | Sensible Effectiveness | User-defined | Heat exchanger sensible effectiveness at design heating and cooling conditions | 3,4,9,10,11,12 |
| Latent Effectiveness | User-defined | Heat exchanger latent effectiveness at design heating and cooling conditions | 3,4,9,10,11,12 |
| Bypass SAT *Set point* | User-defined | If bypass, target supply air temperature | 3,4,9,10,11,12 |
| Fan Power Reduction when in Bypass | User-defined | If bypass, specify fan power reduction (W/CFM) | 3,4,9,10,11,12 |
| Demand Controlled *Ventilation* | *DCV* Application on/off | User-defined | Percentage of block floor area under occupied standby controls, ON/OFF only (See Section 6.5.3.8) with no variable control | 3,4,9,10,11,12 |
| *DCV* Application CO2 | User-defined | Percentage of block floor area under variable *DCV* control (CO2); may include both variable and ON/OFF control | 3,4,9,10,11,12 |
| DOAS | DOAS Fan Power W/cfm | User-defined | Fan electrical input power in W/cfm of supply airflow | 12 |
| DOAS Supplemental Heating and Cooling | User-defined | Heating source, cooling source, energy recovery and respective efficiencies | 12 |
| Maximum SAT *Set point* (Cooling) | User-defined | SAT *set point* if DOAS includes supplemental cooling | 12 |
| Minimum SAT *Set point* (Heating) | User-defined | SAT *set point* if DOAS includes supplemental heating | 12 |
| Heating Plant | *Boiler* *Efficiency* | User-defined | *Boiler* thermal *efficiency* | 1,6,7,9,10,11,12 |
| Heating Water loop Configuration | User-defined | Variable flow primary only; Variable flow primary & secondary; Constant flow primary – variable flow secondary | 1,6,7,9,10,11,12 |
| Heating Water Primary *Pump* Power (W/gpm) (W∙s/L) | User-defined | Heating water constant primary *pump* input W/gpm (W∙s/L) heating water flow | 1,6,7,9,10,11,12 |
| Heating Water Secondary *Pump* Power (W/gpm) (W∙s/L) | User-defined | Heating water variable secondary *pump* input W/gpm (W∙s/L) heating water flow (if primary/secondary) | 1,6,7,9,10,11,12 |
| Heating Water Loop Temperature | User-defined | Heating water supply and return temperatures, °F (°C) | 1,6,7,9,10,11,12 |
| Heating Water Temperature Reset Included | User-defined | Yes/No | 1,6,7,9,10,11,12 |
| Heating Water Loop Supply Temperature Reset | Fixed | Reset HWS by 27.3% of design delta-T (HWS – 70°F (21.1°C) *Space* Heating temperature *set point*) between 20°F (-6.7°C) and 50°F (10°C) OAT | 1,6,7,9,10,11,12 |
| *Boiler* Type | Fixed | Regular where input thermal *efficiency* is less than 86%; Condensing *boiler* otherwise | 1,6,7,9,10,11,12 |
|  | District *Heating* | Fixed | As prescribed in -Table G3.1 No 10 Proposed Building Performance column item (e). | 1, 6, 9, 10, 11 |
| Chilled Water Plant | Chiller Condenser Type | User-defined | Air-cooled or water-cooled; For water-cooled: positive displacement or centrifugal | 6,10,11,12 |
| Chiller Full Load *Efficiency* | User-defined | Chiller *COP* | 6,10,11,12 |
| Number of chillers | User-defined | In simulation, chillers will be sized equally with 1 – 3 chillers | 6,10,11,12 |
| Chilled water coil design delta-T | User-defined | Chilled water supply temperature and chilled water return temperature at design conditions | 6,10,11,12 |
| Chilled Water loop Configuration | User-defined | Variable flow primary only, constant flow primary – variable flow secondary; Variable flow primary & secondary | 6,10,11,12 |
| Chilled Water Primary *Pump* Power (W/gpm) (W∙s/L) | User-defined | Primary *pump* input W/gpm (W∙s/L); chilled water flow | 6,10,11,12 |
| Chilled Water Secondary *Pump* Power (W/gpm) (W∙s/L) | User-defined | Secondary *Pump* input W/gpm (W∙s/L); chilled water flow (if primary/secondary) | 6,10,11,12 |
| Chilled Water Temperature Reset Included | User-defined | Yes/No | 6,10,11,12 |
| Chilled Water Temperature Reset Schedule | Fixed | *Outdoor air* reset: Use input chilled water supply temperature at 80°F *outdoor air* dry bulb and above, chilled water supply temperature add 10°F (-12.2°C) at 60°F (15.6°C) *outdoor air* dry bulb temperature and below, ramped linearly between | 6,10,11,12 |
|  | District cooling | Fixed | As prescribed in -Table G3.1 No 10 Proposed Building Performance column item (f). | 6, 10, 11 |
| Condenser Loop | Condenser Water *Pump* Power (W/gpm) (W∙s/L) | User-defined | *Pump* input W/gpm (W∙s/L) condenser water flow | 6,7,8,10,11,12 |
| Condenser Water *Pump* Control | Fixed | Constant speed, one *pump* per chiller | 6,7,8,10,11,12 |
| Heat Rejection | Heat Rejection Equipment *Efficiency* | User-defined | gpm/hp (L/s∙*kW*) at design conditions where hp is the sum of nameplate fan and integral spray pump motor hp, if applicable | 6,7,8,10,11,12 |
| Open Circuit Cooling Tower Flow Turndown | Fixed | Flow turn down ~~to 50% flow~~ per Section 6.5.5.4 | 6,7,8,10,11,12 |
| Heat Rejection Fan Control | User-defined | Constant or variable speed | 6,7,8,10,11,12 |
| Heat Rejection Approach and Range | User-defined | Design c~~ooling tower~~ heat rejection approach and range temperature | 6,7,8,10,11,12 |
| Heat Pump Loop | Loop flow and Heat Pump Control Valve | Fixed | Two position valve with VSD on *Pump*. | 7,8 |
| Heat Pump Loop Flow Control | Fixed | Loop flow at 3 gpm/ton (0.054 L/s∙*kW*) | 7,8 |
| Heat Pump Loop minimum and maximum Temperature Control: | User-defined | User input; restrict to minimum 20°F (11°C) and maximum 40°F (22°C) temperature difference | 7,8 |
| GLHP Bore Field |  | Fixed | Bore depth = 250 ft (76.2 m).; Bore length 200 ft/ton (17.3 m/*kW*) for greater of cooling or heating load |  |
| Bore spacing = 15 ft (4.6 m). |  |
| Bore diameter = 5 in (127 mm) with ¾ in (25 mm) nominal diameter polyethylene pipe | 8 |
| Ground and grout conductivity = 4.8 Btu∙in/h∙ft2∙°F (0.69 W/m∙°C) |  |
|  |  |

a Applicable systems from Table J1.1.1

**J2.2.3.1 Proposed Building HVAC System Aggregation**

Projects using the Mechanical *System* Performance Rating Method shall comply with all the following requirements.

1. Where multiple fan *systems* serve a single block, fan power shall be based on weighted average using the design supply air cfm (L/s).
2. Where multiple cooling *systems* serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50% of coil capacity serving the block is multi-stage with staged controls.
3. Where multiple heating *systems* serve a single block, thermal *efficiency* or heating COP shall be based on a weighted average using heating capacity.
4. Where multiple *boiler*s or chillers serve a heating water or chilled water loop, *efficiency* shall be based on a weighted average for using heating or cooling capacity.
5. When multiple cooling towers serving a condenser water loop are combined, the cooling tower *efficiency*, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.
6. Where multiple *pump*s serve a heating water, chilled water or condenser water loop, *pump* power shall be based on a weighted average for using design water flow rate.
7. When multiple *system* types with and without economizers are combined, the economizer maximum outside air fraction of the combined *system* shall be based on weighted average of 100% supply air for *systems* with economizers and design *outdoor air* for *systems* without economizers.
8. Multiple *systems* with and without ERVs cannot be combined.
9. *Systems* with and without supply air temperature reset cannot be combined.
10. *Systems* with different fan control (constant volume, multi-speed or *VAV*) for supply fans cannot be combined.

**J3** **Simulation Program**

The *simulation program* shall have the following capabilities:

**J3.1** **Calculation of the TSPR**

The *simulation program* shall calculate both the *TSPR*p and *TSPR*r based only on the input for the *proposed design* and the requirements of this Appendix. The calculation procedure shall not allow the user to directly modify the *building* component characteristics of the *TSPR reference building design* nor the HVAC parameters identified as fixed input in Table J2.2.3.

**J3.2** **TSPR Simulation Program**

All components of the *proposed design* for blocks served by *HVAC* *systems* using this method shall be explicitly modeled by the *simulation program*. The *code official* shall be permitted to approve a *simulation program* for a specified application or limited scope.

**J3.2.1 Minimum Capability**

The *simulation program* shall be approved by the *code official* and shall, at a minimum, have the ability to explicitly model all of the following:

1. 8760 hours per year.
2. Hourly variations in occupancy, lighting power, miscellaneous *equipment* power, *thermostat* *set points*, and *HVAC system* operation, defined separately for each day of the week and holidays.
3. Thermal mass effects.
4. Ten or more *thermal blocks*.
5. Part-load performance curves or other part-load adjustment methods based on *manufacturer’s* part-load performance data for mechanical *equipment.*
6. Capacity and *efficiency* correction curves for *mechanical heating* and *mechanical cooling* *equipment*.
7. Air economizers with integrated control.
8. The *energy* use of all *HVAC* *system* types included in the analysis and *energy* impact from all related fixed and user inputs in Table J2.2.3.
9. The reference system for the building type modeled and the proposed system type(s)
10. Ability to automatically generate the *TSPR reference building design* as specified in Section J4.3

**Informative Note**

The *simulation program* shall include clear prompts or accessible help topic references defining specific parameters and units for all required *building* and *system* characteristic inputs.

**J3.2.2 TSPR Determination**

The *simulation program* shall have the ability to either directly determine the *TSPR*p and *TSPR*ror produce hourly and annual reports of *energy* use by each *energy* source suitable for determining the *TSPR*p and *TSPR*rusing a separate calculation.

**J3.2.3 Load Calculations**

The *simulation program* shall be capable of performing design load calculations to determine required HVAC *equipment* capacities and air and water flow rates in accordance with Section 6.4.2.1 for both the *proposed design* and *TSPR reference building design*.

**J3.2.4 Testing**

**J3.2.4.1** The *simulation program* shall be tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140. The required tests shall include *building* thermal envelope and fabric load tests (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC *equipment* analytical verification tests (Section 5.5), along with the associated reporting (Section 6).

**J3.2.4.2** The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the *simulation program* and input files used for generating the results along with the results of the other *simulation programs* included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.

**Informative Note**

1. There are no pass/fail criteria established by this testing requirement.

2. Based on Section 3 definition, *simulation program* includes the simulation engine and the corresponding user interface. The testing of a *simulation program* only meets the requirements of Section J3 for that *simulation program* and cannot be used as proxy for documenting compliance of another *simulation program* that uses the same simulation engine

**J3.3 Climatic Data**

Climatic Data shall meet the requirements of Section G2.3.

**J3.4 Compliance Report**

The *simulation program* shall generate a report that includes the following:

1. Address of the *building*.
2. Name of individual completing the compliance report.
3. Name and version of the compliance *simulation program,* ~~and~~ the edition of Standard 90.1 the *simulation program* method complies with, and the link to the website that contains the ASHRAE Standard 140 testing results for the version used in accordance with Section J.3.2.4.
4. The dimensions, floor heights and number of *floors* for each block.
5. By block,the *U-factor*, *C-factor*, or *F-factor* for each simulated *opaque* *building envelope* component and the *U-factor* and *SHGC* for each *fenestration* component.
6. By blockor by surface for each block, the *fenestration* area and total area of each *opaque* *building envelope* component
7. By block,a list of the HVAC *equipment* simulated in the *proposed design* including the *equipment* type, fuel type, rated *equipment* *efficiencies*, rated capacities and *system* control parameters.
8. Annual site HVAC *energy* use by end use and energy type for the *proposed design* and *TSPR reference building design.*
9. Annual sum of hourly heating and cooling loads for the *TSPR reference building design.*
10. The HVAC *total system performance ratio* for both the *TSPR reference building design* and the *proposed design* and compliance result in accordance with Section J2.1.4.2.

**Informative Note:**

The *simulation program*, at a minimum, will report compliance with the TSPR based on the compliance criteria in Section 6.2.2.2. Should a jurisdiction adopt other compliance criteria, then a separate calculation of TSPR using the *reference building design* and *proposed design* HVAC energy type input may be necessary.

***J4 CALCULATION PROCEDURE***

Except as specified by this appendix, the *TSPR reference building design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

**J4.1**  **Simulation of the Proposed Design (Non-HVAC)**

The *proposed design* non-HVAC *systems* shall be configured and analyzed as specified in this section. At a minimum, the *simulation program* shall support the *building* use types included in the analysis. The allowed *building* use types are listed in Section J1.1.2.

**J4.1.1 Simplified Block Approach**

The *simulation program* shall model the *building* using one or more simplified geometric simulation *building* blocks, described in Section J2.1. Each block contains one or multiple *thermal blocks*. The *simulation program* shall provide for simplified input described in Section J2.2 and allow for multiple block simulation.

**J4.1.2 Thermal Zoning**

Each *floor* in a blockshall be modeled as a single *thermal block* or as five *thermal blocks* consisting of four perimeter zones and a core zone. Below-*grade* *floors* shall always be modeled as a singleblock. If any façade in the block is less than 45 ft in length, there shall only be a single *thermal block* per *floor*. Otherwise, each *floor* shall be modeled with five *thermal blocks*. A perimeter zone shall be created extending from each façade to a default depth of 15 ft with a user input range of 8 to 20 ft. Where facades intersect, the zone boundary shall be formed by a 45° angle with the two facades. The remaining area or each *floor* shall be modeled as a core zone with no exterior *walls*.

**J4.1.3 Building Use Type**

The *building* use type for each block shall be consistent with the *proposed design* and allowed *building* use types in Section J1.1.2. The occupant density, heat gain, and schedule shall be as specified by Normative Appendix C.

**J4.1.4 Building Envelope Components**

*Building envelope* thermal properties used in the *proposed design* shall be modeled based on the actual *proposed design* using inputs described in Section J2.2.2 and shall comply with all of the following:

1. *Roofs* shall be modeled with insulation above a steel *roof* deck. *Roof* solar absorptance shall be modeled at 0.70 and thermal *emittance* at 0.90.
2. *Above-grade walls* shall be modeled as steel frame construction.
3. Above-*grade* exterior floors shall be modeled as steel frame construction.
4. The area, *U-factor* and *SHGC* of vertical *fenestration* shall be modeled for each façade based on the actual *proposed design*. The *simulation program* shall model a combined single window centered on each façade based on the area and sill height input by the user.
5. The *skylight* area shall be modeled for each *roof* based the actual *proposed design*. *Skylights* shall be combined into a single *skylight* centered on the *roof* of each zone based on the area input by the user.

**J4.1.5 Lighting**

For each block the interior *lighting power density* shall be equal to the applicable allowance in Table 9.5.1 based on the assigned *building* use type. The Lighting profile schedule shall be for the applicable *building* use type as specified by Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls (including daylighting controls) shall be modeled. Exterior lighting shall not be modeled.

**J4.1.6 Miscellaneous Equipment**

The miscellaneous *equipment* schedule and power shall be based on the assigned *building* use type as specified by Normative Appendix C. The impact of miscellaneous *equipment* controls is assumed to be captured by the *equipment* schedule and no explicit controls shall be modeled.

**J4.1.7 Elevators**

Elevators shall not be modeled.

**J4.1.8 Service Water Heating Equipment**

*Service water heating* shall not be modeled.

**J4.1.9 On-site Renewable Energy Systems**

*On-site renewable energy systems* shall not be modeled.

**J4.2 Simulation of the Proposed Design (HVAC)**

The *proposed design HVAC* *systems* shall be configured and analyzed as specified in this section.

### **J4.2.1 HVAC Equipment**

The *simulation program* shall analyze the *control* parameters that meet the mandatory requirements of Section 6.4 and the parameters provided by the user or specified as fixed in Section J2.2.3 as applicable for each *HVAC* *system* included in the *proposed design*.

### **J4.2.2 Supported HVAC Systems**

The *HVAC* *systems* included in the *proposed design* and the *TSPR reference building design* shall be supported by the *simulation program*. *HVAC* *systems* permitted are limited to those shown in Table J1.1.1. The *simulation program* shall support multiple blocks being served by one central *system*.

**J4.2.3 Proposed Building HVAC System Simulation.**

The *HVAC* *systems* shall be modeled as in the *proposed design* with clarifications and simplifications as described in Table J2.2.3 and the following rules:

1. *System* parameters not described in Table J2.2.3 and the following sections shall be simulated to meet the minimum requirements of Section 6.4.
2. Where multiple *system* components serve a block, average values weighed by the appropriate metric as described in Section J2.2.3.1 shall be used.
3. Heat loss from ducts and pipes shall not be modeled.
4. The *simulation program* shall model part-load HVAC *equipment* performance using either:

1. full-load *efficiency* adjusted for fan power input that is modeled separately and typical part-load performance adjustments for the proposed *equipment*,

2. part-load adjustments based on input of both full-load and part-load metrics, or

3. equipment-specific adjustments based on performance data provided by the *equipment* *manufacturer* for the proposed equipment.

1. Part-load variable speed fan and *pump* power shall be calculated using a cubic function with coefficients as shown in Table J4.2.3-1. The independent variable shall be the fraction of design water flow rate for *pump*s and the fraction of design air flow rate for fans as shown in Figure J4.2.3-1.
2. *Demand Controlled Ventilation (DCV*) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the area of the *building* that is covered by *DCV* with coefficients as shown in Table J4.2.3-2. The input shall accommodate two types of *DCV*:
3. Variable control based on people sensor response (CO2 sensor or other)
4. On/Off occupied standby *control* that closes the *VAV* box primary air damper or shuts off *outdoor air* when the zone is completely unoccupied based on an occupancy sensor (See: Section 6.5.3.8).

***Informative Note:***

Due to lower probability occurrence, the On/Off controls are given 1/3 the reduction of the CO2 sensor *DCV*. The OSA reduction factor shall be based on a smaller area of *control* being applied to higher density *spaces* first—adjusted for *building* type, with OSA reduction factors and an application formula as shown.

*For Office, School, and Retail:*

*DCV* effective controlled Floor Area =

AreaVar*DCV* + 1/3 \* AreaON-OFF AND AreaON-OFF  < 1 – AreaVar*DCV*

*For Hotel, Motel, Dormitory, and Multi-family:*

*DCV* effective controlled Floor Area =

AreaVar*DCV* + AreaON-OFF

Where:

AreaVar*DCV* = Fraction of block floor area with variable sensor-based *DCV* *control*

AreaON-OFF = Fraction of block floor area with only occupied standby *control* as defined in Section 6.5.3.8 that does not also have variable sensor-based *demand controlled ventilation*.

**Table J4.2.3-1 Fan and Pump Power Curve Coefficients**

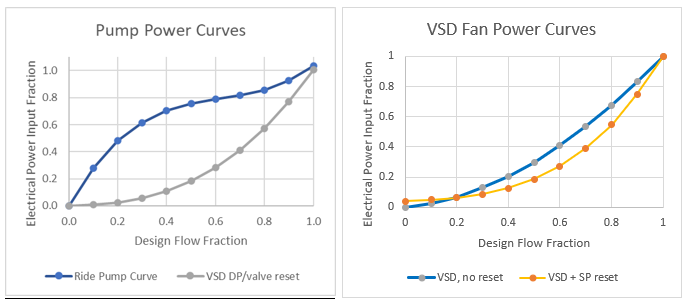
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation Term | Fan Power Coefficients | | *Pump* Power Coefficients | |
| VSD (no SP reset) | VSD + SP reset | Ride *Pump* Curve | VSD + DP/valve reset |
| b | 0.0013 | 0.0408 | 0 | 0 |
| x | 0.147 | 0.088 | 3.2485 | 0.0205 |
| x2 | 0.9506 | -0.0729 | -4.7443 | 0.4101 |
| x3 | -0.0998 | 0.9437 | 2.5295 | 0.5753 |

Figure J4.2.3-1 Fan and Pump Power Performance as a Function of Design Water or Air Flow

**Table J4.2.3-2 DCV Outdoor Air Reduction Curve Coefficients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Equation Term | *DCV* OSA reduction (y) as a function of effective *DCV* control area (x) | | | |
| Office | School | Hotel; Motel; Multi-Family; Dormitory | Retail |
| b | 0 | 0 | 0 | 0 |
| x | 0.4053 | 0.2676 | 0.5882 | 0.4623 |
| x2 | -0.8489 | 0.7753 | -1.0712 | -0.848 |
| x3 | 1.0092 | -1.5165 | 1.3565 | 1.1925 |
| x4 | -0.4168 | 0.7136 | -0.6379 | -0.5895 |

**Figure J4.2.3-2 DCV OSA Reduction as a Function of Controlled Floor Area**



**J4.3 Simulation of the TSPR Reference Building Design.**

The *TSPR reference building design* shall be configured and analyzed as specified in this section.

**J4.3.1** **Non-HVAC Inputs**

Blocks, *HVAC zones*, *building* use types, schedules, occupant density, heat gains, *building envelope* components, lighting power, and miscellaneous *equipment loads* shall be modeled the same as in the *proposed design.*

Elevators, *service water-heating* *equipment*, and *on-site renewable energy systems* shall not be modeled; same as in the *proposed design*.

**J4.3.2** **HVAC Equipment.**

The *TSPR reference building design* HVAC *equipment* consists of separate *space* conditioning *systems* and dedicated *outdoor air* *systems* as described in Table J4.3.2-1 through Table J4.3.2-3 for the appropriate *building* use types. VSD fan and pump power shall be modeled using parameters in Table J4.2.3-1.

**Table J4.3.2-1 - TSPR Reference Building Design HVAC Complex Systems**

|  |  |  |
| --- | --- | --- |
| **Building Type Parameter** | **Large Office** | **School** |
| **System Type** | *VAV*/ RH  Water-cooled Chiller/  Gas *Boiler* | *VAV*/ RH  Water-cooled Chiller/  Gas *Boiler* |
| Fan control | VSD, no SP reset | VSD, no SP reset |
| Main fan power (W/CFM (W∙s/L) Proposed ≥ MERV13 | 1.165 (2.485) | 1.165 (2.485) |
| Main fan power (W/CFM (W∙s/L) proposed < MERV13 | 1.066 (2.274) | 1.066 (2.274) |
| Zonal fan power (W/CFM (W∙s/L)) | NA | NA |
| Minimum zone airflow fraction | 1.5\* Voz | 1.2 \* Voz |
| Heat/cool sizing factor | 1.25/1.15 | 1.25/1.15 |
| *Outdoor air* economizer | Yes except 4A | Yes except 4A |
| Occupied OSA (= proposed) | Sum(Voz)/0.75 | Sum(Voz)/0.65 |
| *Energy* recovery ventilator *efficiency* ERR  (Enthalpy Recovery Ratio)  ERV bypass SAT *set point* | NA | 50%  60°F except 4A |
| *DCV* | No | No |
| Cooling Source | (2) Water- cooled Centrifugal Chillers | (2) Water- Cooled Screw Chillers |
| Cooling Efficiency | Table G3.5.3 | Table G3.5.3 |
| Heating source (reheat) | Gas *Boiler* | Gas *Boiler* |
| Furnace or *boiler* *efficiency* | 75% Et | 80% Et |
| Condenser heat rejection |  | |
| Cooling tower *efficiency* (gpm/hp (L/s∙*kW*))—See G3.1.3.11 | 38.2 (3.23) | 38.2 (3.23) |
| Open circuit cooling tower turndown (> 300 ton (1060 *kW*)) | 50% | 50% |
| *Pump* (constant flow/variable flow) | Constant Flow; 10°F (5.6°C) range | Constant Flow; 10°F (5.6°C) range |
| Open circuit cooling tower approach | G3.1.3.11 | G3.1.3.11 |
| Cooling condenser *pump* power (W/gpm (W∙s/L)) | 19 (300) | 19 (300) |
| Cooling primary *pump* power (W/gpm (W∙s/L)) | 9 (142) | 9 (142) |
| Cooling secondary *pump* power (W/gpm (W∙s/L)) | 13 (205) | 13 (205) |
| Cooling coil chilled water delta-T, °F (°C) | 12 (6.7) | 12 (6.7) |
| Design chilled water supply temperature, °F (°C) | 44 (6.7) | 44 (6.7) |
| Chilled water supply temperature (CHWST)  reset *set point* vs OAT, °F (°C) | CHWST/OAT:  44-54/ 80-60 (6.7-12.2/ 26.7-15.6) (see Apx G) | CHWST/OAT:  44-54/ 80-60 (6.7-12.2/ 26.7-15.6) (see Apx G) |
| CHW cooling loop *pump*ing control | 2-way Valves & *pump* VSD | 2-way Valves & *pump* VSD |
| Heating *pump* power (W/gpm (W∙s/L)) | 16.1 (254) | 19 (254) |
| Heating oil HW dT. °F (°C) | 50 (10) | 50 (10) |
| Design HWST. °F (°C) | 180 (82) | 180 (82) |
| HWST reset *set point*  vs OAT, °F (°C) | HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10) | HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10) |
| Heat loop *pumping* control | 2-way Valves & *pump* VSD | 2-way Valves & *pump* VSD |

**Table J4.3.2-2 - TSPR Reference Building Design HVAC Simple Systems 1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Building Type**  **Parameter** | **Medium Office** | **Small Office** | **Retail** |
| *System* type | Package *VAV* - Hydronic Reheat | PSZ-AC | PSZ-AC |
| Fan control | VSD, no SP reset | Constant Volume | Constant Volume |
| Main fan power (W/CFM (W∙s/L))  proposed ≥ MERV13 | 1.285 (20.29) | 0.916 (14.46) | 0.899 (14.19) |
| Main fan power (W/CFM (W∙s/L))  proposed < MERV13 | 1.176 (18.59) | 0.850 (13.42) | 0.835 (13.42) |
| Zonal fan power (W/CFM (W∙s/L)) | NA | NA | NA |
| Minimum zone airflow fraction | 30% | NA | NA |
| Heat/cool sizing factor | 1.25/1.15 | 1.25/1.15 | 1.25/1.15 |
| *Outdoor air* economizer | Yes except 4A | Yes except 4A | Yes except 4A |
| Occupied OSA source |  | | |
| *Energy* recovery ventilator | No | No | No |
| *DCV* | No | No | No |
| Cooling source | DX, multi-stage | DX, single stage | DX, single stage |
| Cooling *COP* (net of fan) | 3.40 | 3.00 | 3.50 |
| Heating source | Gas *Boiler* | Furnace | Furnace |
| Heating *COP* (net of fan) / furnace or *boiler* *efficiency* | 75% E*t* | 80% E*t* | 80% E*t* |

**Table J4.3.2-3 - TSPR Reference Building Design HVAC Simple Systems 2**

|  |  |  |
| --- | --- | --- |
| **Building Type**  **Parameter** | **Hotel** | **Multifamily** |
| *System* type | *PTAC* | *PTAC* |
| Fan control | Constant Volume | Constant Volume |
| Main fan power (W/CFM (W∙s/L)) | 0.300 (4.74) | 0.300 (4.74) |
| Heat/cool sizing factor | 1.25/1.15 | 1.25/1.15 |
| *Outdoor air* economizer | No | No |
| Occupied OSA source | Packaged unit, occupied damper | Packaged unit, occupied damper |
| *Energy* recovery ventilator | No | No |
| *DCV* | No | No |
| Cooling source | DX, 1 stage | DX, 1 stage |
| Cooling *COP* (net of fan) | 3.20 | 3.20 |
| Heating source | (2) Hydronic *Boiler* | (2) Hydronic *Boiler* |
| Heating *COP* (net of fan) / furnace or *boiler* *efficiency* | 75% E*t* | 75% E*t* |
| Heating *pump* power (W/gpm (W∙s/L)) | 19 (300) | 19 (300) |
| Heating coil heating water delta-T, °F (°C) | 50 (27.8) | 50 (27.8) |
| Design HWST, °F (°C) | 180 (82.2) | 180 (82.2) |
| HWST reset *set point*  vs OAT, °F (°C) | HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10) | HWST/OAT: 180/150 20/50 (82-65.6/ -6.7-10) |
| Heat loop *pump*ing control | 2-way Valves & ride *pump* curve | 2-way Valves & ride *pump* curve |