

Boulder Modified Appendix G Protocol

This document contains sections of ASHRAE 90.1-2016 Normative Appendix G that have been modified to reflect specific requirements of the 2020 City of Boulder Energy Conservation Code. Only sections of Appendix G that have been modified from the original language are included in this document.

Additional Definitions

Energy Use Intensity (EUI): the annual site energy use per square foot in units of kBtu/sq.ft of building floor area.

Equipment Power Density (EPD): the power per unit area of equipment serving plug and process loads of the building or space, expressed in W/ft² of building floor area.

Section G1 GENERAL

Section G1.2. Performance Rating

G1.2.1 Mandatory Provisions

This *performance rating method* requires conformance with the following provisions:

- a. All mandatory requirements of Chapter 4 of the *2020 Boulder Energy Code* must be met. These super-cede the mandatory requirements in Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 of ASHRAE Standard 90.1-2016.
- b. The interior lighting power shall not exceed the *interior lighting power allowance* determined using either Tables G3.7 or G3.8 and the methodology described in Sections 9.5.1 and 9.6.1.
- c. The proposed envelope U factors shall meet all of the performance requirements listed in Table 5.5-5. No tradeoffs of envelope performance below these levels are allowed. Exceptions to the 40% window-to-wall area ratio can be made provided project can still meet required building energy performance requirements.
- d. The proposed HVAC equipment efficiencies at a minimum shall meet the performance requirements determined in the Tables 6.8.1-1 through Table 6.8.1-16.

G1.2.2 Performance Rating Calculation

All new construction in Boulder with a construction value greater than \$500,000 must comply with Section G1.2.2.1, G1.2.2.2 or G1.2.2.3.

G1.2.2.1 Modeled Baseline

Compliance with the Modeled Baseline path requires that the Performance Cost Index target (PCIt) for the *proposed design* be reduced by 25 percent for mixed-fuel buildings and 20 percent for all-electric buildings from a PCIt that complies with the ASHRAE 90.1-2016.

In addition to following the protocols below, energy use for the *proposed design* shall also be reported to the code official as *energy use intensity* (EUI) in kBtu/sf/yr.

Mixed Fuel Buildings:

$$PCIt = 0.75 \times \frac{(BBUEC + (BPF \cdot BBREC))}{BBP} \quad (\text{Eq. G1.2.2.1})$$

All Electric Buildings:

$$PCIt = 0.80 \times \frac{(BBUEC + (BPF \cdot BBREC))}{BBP} \quad (\text{Eq. G1.2.2.2})$$

where:

- PCIt = The maximum Performance Cost Index for the *proposed design* to comply with the Boulder Energy Code
- BBUEC = Baseline Building Unregulated Energy Cost. The portion of the annual energy of a *baseline building design* that is due to *unregulated energy use*.
- BBREC = Baseline *Building Regulated Energy Cost*. The portion of the annual *energy* of a *baseline building design* that is due to *regulated energy use*.
- BPF = *Building Performance Factor* (BPF) from Table G1.1. For *building* types not listed in the table use "All Others." Where a *building* includes multiple building area types, the required BPF shall be equal to the area-weighted average of the *building* area types. (This table replaces Table 4.2.1.1 in 90.1-2016)
- BBP = *Baseline Building Performance*. The annual *energy cost* of the *baseline building design* including both *regulated* and *unregulated energy use*.

Table G1.1 Building Performance Factors for use in Equation G1.2.2.2

Table G1.1 Building Performance Factors for Climate Zone 5B (Boulder)	
Use Type	BPF
Office	0.56
Retail	0.58
School	0.43
Healthcare	0.55
Restaurant	0.62
Hotel	0.58
Warehouse	0.50
Apartment	0.78
All Others	0.55

G1.2.2.2 Fixed Performance Target

Projects of the types listed in Table G1.2 may use the site EUI targets identified in the table in lieu of baseline modeling of performance cost index (PCI). The *proposed building model* predicted performance will be demonstrated not to exceed the values in this table, using the energy

modeling procedures described in this appendix. *Buildings* with multiple occupancy types listed in Table G1.2 (only) may develop a performance target based on a weighted average EUI calculated by floor area of each occupancy type.

Table G1.2 Fixed Performance Targets for Performance Pathway 2

Table G1.2 Site EUI Targets Climate Zone 5B (Boulder)	
Building Type	Performance Targets kBtu/ft²
Medium Office	23
Mid-rise Apartment	32
Primary School	34
Small Office	19
Secondary School	31
Warehouse	11

G1.2.2.3 Measured Performance Outcome

With approval of the building official, projects may demonstrate compliance with this code by proving that the building has achieved the modeled performance calculated in accordance with Section G1.2.2.1 or G1.2.2.2 based on metered energy use after occupancy. Code Section C407.3.3 outlines how projects comply with this path.

The establishment of this new pathway helps projects to move toward delivering measured building performance aligned with the city’s 2050 GHG reduction goals by encouraging the building industry to begin to consider building performance outcome as a basis for energy code compliance.

Section G1.3 Documentation Requirements

The building permit application for performance rating shall include all *building* and mechanical drawings and information necessary to verify that the building envelope and mechanical design for the project corresponds with the annual energy analysis. This includes, but is not limited to, equipment cut sheets, specifications, sequence of operation. If credit for lighting energy savings is proposed to be taken, then electrical drawings and proposed lighting power density calculation shall be submitted. If credit is proposed to be taken for energy savings from plug-in equipment or control measures then such measures should be pre-approved by the building official. Measures of the project that are not approved as part of the building permit application shall be modeled the same way in both the *proposed building* and *baseline design* and shall comply with requirements of this code.

Simulated performance shall be documented, and documentation shall be submitted to the building official. The information shall be submitted in a report and shall include the following:

- a. A brief description of the project, the key *energy efficiency* improvements compared with the requirements in Sections 5 through 10, the *simulation program* used, the version of the *simulation program*, the performance pathway used (per Boulder Energy Code Section C407.3), and the results of the *energy analysis*. This summary shall contain the calculated values for the *baseline building performance (or EUI target)*, the *proposed building performance*, and the percentage improvement.
- b. 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*.
- c. 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.
- d. A list showing compliance for the *proposed design* with all of the mandatory provisions of the Boulder Energy Code.
- e. Documentation of compliance with the prescriptive requirements of Sections 5.5 and Tables 6.8.1 to 6.8.16 (Identified as the performance backstop requirements in Section C407.4.3 of the Boulder Energy Code).
- f. A table with a summary by end use of the *energy use intensity* (EUI) in the *proposed building performance*.
- g. A site plan showing all adjacent *buildings* and topography that may shade the proposed *building* (with estimated height or number of stories).
- h. *Building elevations* and *floor plans* (schematic is acceptable).
- i. A diagram showing the *thermal blocks* used in the computer simulation.
- j. An explanation of any significant modeling assumptions.
- k. 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]).
- l. Input and output reports from the *simulation program* or compliance software, including 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). The output reports shall also show the amount of *unmet load hours* for both the *proposed design* and *baseline building design*.
- m. *Purchased energy rates* used in the simulations.
- n. An explanation of any error messages noted in the *simulation program* output.
- o. For any exceptional calculation methods employed, document the predicted *energy savings* by *energy type*, the *energy use intensity savings*, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.
- p. The reduction in *proposed building performance* associated with *on-site renewable energy*.

The Commercial Energy Modeling Summary Report template can be found at www.BoulderEnergyCode.com.

Section G2 SIMULATION GENERAL REQUIREMENTS

G2.1 Performance Calculations

The *proposed building performance* and *baseline building performance* shall be calculated using the following:

- a. The same simulation program
- b. The same weather data
- c. The same energy rates
- d. The same required *building* schedules (unless changes are pre-approved by the building official)
- e. The same required *equipment* power densities (unless changes are pre-approved by the building official)

Section G2.4 Renewable, Recovered, and Purchased Energy

G2.4.1 On-site Renewable Energy and 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*. *On-site renewable energy* generated by systems included on the *building permit* that is used by the *building* shall be subtracted from the *proposed design energy* consumption prior to calculating the *proposed building performance*. The reduction in *proposed building site energy performance (EUI)* associated with *on-site renewable energy* systems shall be at least 5 percent of the calculated *proposed building performance*. Where the proposed design includes electricity generated from sources other than *on-site renewable energy*, the baseline design shall include the same generation system.

Section G3 CALCULATION OF THE PROPOSED DESIGN AND BASELINE BUILDING PERFORMANCE

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

Table G3.1: No. 4 Schedules

No.	Proposed Building Performance	Baseline Building Performance
4. Schedule	<p>Standardized required building schedules provided in Table G.4 shall be used. These schedules are typical of the proposed building type. They are capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, infiltration and service hot water usage. The schedules that are not specified should be determined by the designer and approved by the rating authority.</p> <p>Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, infiltration, service hot water usage and HVAC system operation shall be used. <u>Projects are required to use the schedules provided in Table G.4.</u></p> <p><u>Exception: For buildings where non-standard operations are anticipated, projects may propose specific schedule modifications for pre-approval by the building official. The schedules shall be typical of the proposed building type as determined by the designer and approved by the rating authority.</u></p> <p>Temperature and Humidity Schedules. Temperature and humidity control set points and schedules as well as temperature control throttling range shall be the same for <i>proposed design</i> and <i>baseline building design</i>.</p>	<p>Same as <i>proposed design</i>.</p> <p>Exceptions:</p> <ol style="list-style-type: none"> 1. <i>Set points</i> 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. Schedules may be allowed to differ between <i>proposed design</i> and <i>baseline building design</i> when necessary to model nonstandard efficiency measures, provided that the revised schedules have been approved by the <i>rating authority</i>. Measures that may warrant use of different schedules include but are not limited to <i>automatic lighting controls, automatic natural ventilation controls, automatic demand control ventilation controls, and automatic controls that reduce service water-heating loads or process loads</i>. In no case shall schedules differ where the <i>controls</i> are <i>manual</i>

<p>HVAC Fan Schedules. Schedules for HVAC fans that provide <i>outdoor air for ventilation</i> shall run continuously whenever <i>spaces</i> are occupied and shall be cycled ON and OFF to meet heating and cooling loads during unoccupied hours.</p> <p>Exceptions:</p> <ol style="list-style-type: none"> 1. Where no heating and/or cooling <i>system</i> is to be installed, and a heating or cooling <i>system</i> is being simulated only to meet the requirements described in this table, heating and/or cooling <i>system</i> 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 <i>spaces</i> that have health- and safety-mandated minimum <i>ventilation</i> requirements during unoccupied hours. 3. HVAC fans shall remain on during occupied and unoccupied hours in <i>systems</i> primarily serving <i>computer rooms</i>. 	<p>(e.g., <i>manual</i> operation of light switches or <i>manual</i> operation of windows).</p>
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Table G3.1: No. 12 Receptacle and Other Loads

No.	Proposed Building Performance	Baseline Building Performance
	<p>12. Receptacle and Other Loads</p> <p>Receptacle and <i>process loads</i>, such as those for office and other <i>equipment</i>, shall be estimated based on the <i>building area type or space type category</i> and shall be assumed to be identical in the <i>proposed design</i> and <i>baseline building design</i>, except as specifically approved by the building official. only when quantifying performance that exceeds the requirements of Standard 90.1 but not when the <i>Performance Rating Method</i> is used as an alternative path for minimum standard compliance in accordance with Section 4.2.1.1. These loads <u>Receptacle and process loads</u> shall always be included in simulations of the <i>building</i>. These loads shall be included when calculating the <i>proposed building performance</i> and the <i>baseline building performance</i> as required by Section G1.2.1.</p> <ol style="list-style-type: none"> a. Where power and other <i>systems</i> covered by Sections 8 and 10 have been designed and submitted with design documents, those <i>systems</i> shall be determined in accordance with Sections 8 and 10. b. Where power and other <i>systems</i> covered by Sections 8 and 10 have not been submitted with design documents, those <i>systems</i> shall comply with but not exceed the requirements of those sections. c. <u><i>Equipment controls (e.g. Computer Power Management, Advanced Power Strips etc.)</i></u> designed to improve energy performance shall be modeled in the <i>proposed design</i> using <u>equipment schedule adjustments approved by the <i>rating authority</i>.</u> 	<p><u>Equipment power density in the baseline building design shall be determined using the whole building or space-by-space values in Table G.5.1 and Table G.5.2. The default values cover energy used for equipment that is normally plugged into convenience outlets and does not include process equipment such as commercial refrigeration cases, walk-in freezers and refrigerators, cooking equipment, elevators and other devices. Standardized receptacle hourly schedules shall be used with the specified power densities.</u></p> <p>Motors shall have minimum <i>efficiency</i> ratings found in Table G3.9.1. Other <i>systems</i> covered by Section 10 and miscellaneous loads shall be modeled as identical to those in the <i>proposed design</i>. , including schedules of operation and control of the equipment. 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 <i>proposed building performance</i> and the <i>baseline building performance</i>.</p> <p>Exceptions: When quantifying performance that exceeds the requirements of Standard 90.1, variations of the power requirements, schedules, or <i>control</i> sequences of the <i>equipment</i> modeled in the <i>baseline building design</i> from those in the <i>proposed design</i> shall be approved by the <i>building official</i> based on documentation that the <i>equipment</i> installed in the</p>

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.

Section G4 REQUIRED SCHEDULES (New Section)

All projects using the performance pathway shall use the mandatory *building schedules and equipment* power density schedules provided Table G4 below.

Exceptions:

- 1) The code official may approve alternate schedules prior to submittal to account for special use conditions. The same values must be used in the *baseline* and *proposed building model*.
- 2) The code official may approve alternate schedules for unregulated loads in the *proposed building design* that reflect plug and process load management strategies.

Table G4 Required Schedules for Calculating Proposed and Baseline Building Performance

C-1 Assembly Schedules			Hour Ending																								
Description	Type	Day	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	12pm	
Occupancy	Fraction	WD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.20	0.20	0.20	0.10	0.00	0.00	
		Sat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.20	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.80	0.80	0.10	0.00
		Sun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.20	0.00
Lights	Fraction	WD	0.05	0.05	0.05	0.05	0.05	0.05	0.35	0.35	0.35	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.25	0.05	
		Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.30	0.30	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.05	
		Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.30	0.30	0.30	0.30	0.30	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.05	
Receptacle	Fraction	WD	0.05	0.05	0.05	0.05	0.05	0.40	0.40	0.40	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.25	0.05	
		Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.30	0.30	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.05	
		Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.30	0.30	0.30	0.30	0.30	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.05	
Infiltration	Fraction	WD	1.00	1.00	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.00	
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.00	
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.00	
ClgSetPt	Temperature	WD	80	80	80	80	80	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	80	
		Sat	80	80	80	80	80	80	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	80	
		Sun	80	80	80	80	80	80	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	80	
HtgSetPt	Temperature	WD	60	60	60	60	60	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	60	
		Sat	60	60	60	60	60	60	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	60	
		Sun	60	60	60	60	60	60	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	60	
Service Hot Water	Fraction	WD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.35	0.35	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	
		Sat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.30	0.00	0.00	0.00	
		Sun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.30	0.00	0.00	0.00	
Servers/ 24/7 load	Fraction	WD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

C-2 Health			Hour Ending																							
Description	Type	Day	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	12pm
Occupancy	Fraction	WD	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.50	0.60	0.60	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.60	0.50	0.40	0.40	0.40	0.40
		Sat	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.50	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.50	0.50	0.40	0.40	0.40
		Sun	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.40	0.40
Lights	Fraction	WD	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.50	0.50	0.50	0.50	0.50	0.50	0.50
		Sat	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.50	0.50	0.50	0.50	0.50	0.50	0.50
		Sun	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Receptacle	Fraction	WD	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.70	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.60	0.60	0.60	0.60	0.60	0.60	0.40
		Sat	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.60	0.60	0.60	0.60	0.60	0.40
		Sun	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Infiltration	Fraction	WD	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
		Sat	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
		Sun	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
ClgSetPt	Temperature	WD	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
		Sat	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
		Sun	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
HtgSetPt	Temperature	WD	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
		Sat	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
		Sun	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Service Hot Water	Fraction	WD	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.17	0.58	0.66	0.78	0.82	0.71	0.82	0.78	0.74	0.63	0.41	0.18	0.18	0.18	0.15	0.15	0.15
		Sat	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.20	0.28	0.30	0.30	0.24	0.24	0.23	0.23	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Sun	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Servers/ 24/7 load	Fraction	WD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

C-4 Manufacturing			Hour Ending																									
Description	Type	Day	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	12pm		
Occupancy	Fraction	WD	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.95	0.95	0.95	0.95	0.50	0.95	0.95	0.95	0.95	0.30	0.10	0.10	0.10	0.10	0.05	0.00	0.00	0.00
		Sat	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.30	0.30	0.30	0.30	0.10	0.10	0.10	0.10	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Sun	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lights	Fraction	WD	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.30	0.85	0.85	0.85	0.85	0.75	0.85	0.85	0.85	0.85	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
		Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.30	0.30	0.30	0.30	0.15	0.15	0.15	0.15	0.15	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
		Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Receptacle	Fraction	WD	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.30	0.90	0.90	0.90	0.90	0.80	0.90	0.90	0.90	0.90	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
		Sat	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.10	0.30	0.30	0.30	0.30	0.15	0.15	0.15	0.15	0.15	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
		Sun	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Infiltration	Fraction	WD	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ClgSetPt	Temperature	WD	80	80	80	80	80	80	75	75	75	75	75	75	75	75	75	75	75	75	80	80	80	80	80	80	80	
		Sat	80	80	80	80	80	80	75	75	75	75	75	75	75	75	75	75	75	75	80	80	80	80	80	80	80	
		Sun	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
HtgSetPt	Temperature	WD	60	60	60	60	60	60	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	
		Sat	60	60	60	60	60	60	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	
		Sun	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Service Hot Water	Fraction	WD	0.05	0.05	0.05	0.05	0.05	0.08	0.07	0.19	0.35	0.38	0.39	0.47	0.57	0.54	0.34	0.33	0.44	0.26	0.21	0.15	0.17	0.08	0.05	0.05	0.05	
		Sat	0.05	0.05	0.05	0.05	0.05	0.08	0.07	0.11	0.15	0.21	0.19	0.23	0.20	0.19	0.15	0.12	0.14	0.07	0.07	0.07	0.07	0.09	0.05	0.05	0.05	
		Sun	0.04	0.04	0.04	0.04	0.04	0.07	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.09	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.07	0.04	0.04	
Servers/ 24/7 load	Fraction	WD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

C-3 Hotel/Motel			Hour Ending																								
Description	Type	Day	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	12pm	
Occupancy	Fraction	WD	0.90	0.90	0.90	0.90	0.90	0.90	0.70	0.40	0.40	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.50	0.50	0.50	0.70	0.70	0.80	0.90	0.90
		Sat	0.90	0.90	0.90	0.90	0.90	0.90	0.70	0.40	0.40	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.50	0.50	0.50	0.70	0.70	0.80	0.90	0.90
		Sun	0.90	0.90	0.90	0.90	0.90	0.90	0.70	0.40	0.40	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.50	0.50	0.50	0.70	0.70	0.80	0.90	0.90
Lights	Fraction	WD	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
		Sat	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
		Sun	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
Receptacle	Fraction	WD	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
		Sat	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
		Sun	0.10	0.10	0.10	0.10	0.10	0.30	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.60	0.80	0.90	0.80	0.60	0.30	
Infiltration	Fraction	WD	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
		Sat	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
		Sun	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
ClgSetPt	Temperature	WD	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
		Sat	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
		Sun	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78	78
HtgSetPt	Temperature	WD	60	60	60	60	60	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		Sat	60	60	60	60	60	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		Sun	60	60	60	60	60	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Service Hot Water	Fraction	WD	0.00	0.00	0.00	0.05	0.05	0.05	0.80	0.70	0.50	0.40	0.25	0.25	0.25	0.25	0.50	0.60	0.70	0.70	0.40	0.25	0.20	0.20	0.05	0.05	
		Sat	0.00	0.00	0.00	0.05	0.05	0.05	0.80	0.70	0.50	0.40	0.25	0.25	0.25	0.25	0.50	0.60	0.70	0.70	0.40	0.25	0.20	0.20	0.05	0.05	
		Sun	0.00	0.00	0.00	0.05	0.05	0.05	0.80	0.70	0.50	0.40	0.25	0.25	0.25	0.25	0.50	0.60	0.70	0.70	0.40	0.25	0.20	0.20	0.05	0.05	
Servers/ 24/7 load	Fraction	WD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Sat	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		Sun	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

C-5 Office			Hour Ending																								
Description	Type	Day	1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	12pm	
Occupancy	Fraction	WD	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.95	0.95	0.95	0.95	0.50	0.95	0.95	0.95	0.95	0.30	0.10	0.10	0.10	0.10	0.05	0.00	0.00
		Sat																									

Convention Center	0.75
Courthouse	1.67
Dining: Bar Lounge/Leisure	1.32
Dining: Cafeteria/Fast Food	1.37
Dining: Family	1.26
Dormitory	1.96
Exercise Center	0.67
Fire Station	1.54
Gymnasium	0.67
Healthcare Clinic	1.22
Hospital	1.25
Hotel	1.56
Library	0.94
Manufacturing Facility	0.34
Motel	1.56
Motion Picture Theater	0.74
Multifamily	1.42
Museum	0.74
Office	0.75
Parking Garage	n.a.
Penitentiary	1.49
Performing Arts Theater	0.74
Police Station	1.54
Post Office	0.91
Religious Building	0.30
Retail	0.70
School/University	0.69
Sports Arena	0.75
Town Hall	0.75
Transportation	0.52
Warehouse	0.30
Workshop	0.43

Addition to Appendix G: Table G.5.2 Plug Load Modeling Requirements- Space-by-Space

Space-by-Space Classifications	Default Equipment Power Density (W/ft²)
Audience Seating Area, Auditorium	0.75
Audience Seating Area, Convention Center	0.75
Audience Seating Area, Exercise Center	0.67
Audience Seating Area, Gymnasium	0.67
Audience Seating Area, Motion Picture Theater	0.74
Audience Seating Area, Penitentiary	0.75
Audience Seating Area, Performing Arts Theater	0.74

Audience Seating Area, Religious Building	0.73
Audience Seating Area, Sports Arena	0.74
Audience Seating Area, Transportation Facility	0.75
Audience Seating Area, Other	0.75
Atrium, Less than or equal to 40 ft	n.a.
Atrium, More than 40 ft	n.a.
Banking Activity Area,	1.72
Classroom/Lecture/Training, Penitentiary	0.59
Classroom/Lecture/Training, K-12, laboratory and shops	0.59
Classroom/Lecture/Training, Other	0.59
Conference/Meeting/Multipurpose,	0.73
Confinement Cells,	1.49
Copy/Print Room,*	UWBD
Corridor, Assisted Living	1.40
Corridor, Hospital	1.25
Corridor, Manufacturing	0.34
Corridor, Other*	UWBD
Courtroom,	1.49
Computer Room,	n.a.
Dining Area, Penitentiary	1.26
Dining Area, Assisted Living	1.32
Dining Area, Bar Lounge/Leisure	1.26
Dining Area, Cafeteria or Fast Food	1.37
Dining Area, Family Dining	1.32
Dining Area, Other	1.32
Electrical/Mechanical,*	UWBD
Emergency Vehicle Garage,	0.58
Food Preparation ,	1.32
Guest Room,	1.56
Judges Chambers,	1.49
Laboratory, Classrooms	3.34
Laboratory, Other	3.34
Laundry/Washing Area,	0.52
Loading Dock, Interior,	n.a.
Lobby, Assisted Living	1.40
Lobby, Elevator*	UWBD
Lobby, Hotel	1.56
Lobby, Motion Picture Theater	0.74
Lobby, Performing Arts Theater	0.74
Lobby, Other*	UWBD
Locker Room ,	n.a.
Lounge/Break, Healthcare	1.25
Lounge/Break, Other*	UWBD
Office, Enclosed	0.75

Office, Open Plan	0.75
Parking Area, Interior,	n.a.
Pharmacy Area,	0.55
Restrooms , Assisted Living	1.40
Restrooms , Other*	UWBD
Sales Area,	0.55
Seating Area General,*	UWBD
Stairway,*	UWBD
Storage, Hospital	1.25
Storage, >= 50 ft ²	0.31
Storage, < 50 ft ²	0.31
Vehicular Maintenance,	0.50
Workshop,	0.43
Assisted Living, Chapel	1.40
Assisted Living, Recreation Room	1.40
Convention Center, Exhibit Space	0.75
Dormitory, Living Quarters	1.96
Fire Station, Sleeping Quarters	1.54
Gymnasium/Fitness Center, Exercise Area	0.67
Gymnasium/Fitness Center, Playing Area	0.67
Healthcare, Emergency Room	1.25
Healthcare, Exam/Treatment	1.25
Healthcare, Supply Room	1.25
Healthcare, Nursery	1.25
Healthcare, Nurses' Station	1.25
Healthcare, Operating Room	1.25
Healthcare, Patient Room	1.25
Healthcare, Physical Therapy	1.25
Healthcare, Recovery Room	1.25
Library, Reading Area	0.94
Library, Stacks	0.94
Manufacturing Facility, Detailed Manufacturing	0.34
Manufacturing Facility, Equipment Room	0.34
Manufacturing Facility, Extra High Bay (>50 ft Floor to Ceiling Height)	0.34
Manufacturing Facility, High Bay (25–50 ft Floor to Ceiling Height)	0.34
Manufacturing Facility, Low Bay (<25 ft Floor to Ceiling Height)	0.34
Museum, General Exhibition	0.74
Museum, Restoration	0.43
Post Office, Sorting Area	1.67
Religious Building, Fellowship Hall	0.30
Religious Building, Worship/Pulpit/Choir	0.30
Retail, Dressing/Fitting Room	0.82

Retail, Mall Concourse	0.00
Sports Arena Playing Area, Class I	0.67
Sports Arena Playing Area, Class II	0.67
Sports Arena Playing Area, Class III	0.67
Sports Arena Playing Area, Class IV	0.67
Transportation, Baggage/Carousel Area	0.76
Transportation, Concourse	0.76
Transportation, Ticket Counter	0.76
Warehouse, Medium/Bulky Items on Pallets	0.31
Warehouse, Smaller Hand Carried Items	0.31

Note: *UWBD = Use whole building data