ADDENDA

ANSI/ASHRAE/IBPSA Addendum j to
ANSI/ASHRAE Standard 209-2018

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

Approved by ASHRAE and the American National Standards Institute on September 30, 2024, and by the International Building Performance Simulation Association on September 26, 2024.

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 ISSN 1041-2336

ASHRAE®

International Building Performance Simulation Association

Approved American National Standard ANSI www.ansi.org

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FOREWORD

Addendum j makes changes to Modeling Cycle #11—Postoccupancy Modeling. These changes (1) align the level of detail with the level of detail in other modeling cycles, (2) incorporate comments on the original language, and (3) add informative notes/clarify the language.

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

Addendum j to Standard 209-2018

Modify Section 8 as shown.

8. OPERATIONAL MODELING~~POSTOCCUPANCY MODELING~~

8.1 Modeling Cycle #11—Operational~~Postoccupancy~~ Energy Performance Comparison

8.1.1 Purpose. Inform future *energy model* assumptions and potentially identify operational energy savings through a comparison of modeled performance to measured energy use. ~~Compare the modeled performance of the last design- or construction-phase *energy model* to the actual measured energy use and weather conditions of the building in operation. This comparison is intended to inform future *energy model* assumptions and potentially identify operational energy savings opportunities. The scope of this section does not include adjusting model inputs to calibrate the *energy model* to the measured energy use, though the comparison described is a fundamental first step to any proposed calibration.~~

Informative Note: The scope of this section does not include adjusting model inputs to calibrate the *energy model* to the measured energy use; however, the comparison described above is a fundamental first step in the calibration process.

8.1.2 Applicability. This *modeling cycle* shall be performed no sooner than twelve months after initial occupancy. The comparison year shall include twelve consecutive months of building operations.

Informative Note: After a building is completed, it may take several months to reach the intended occupancy and regular operation. The 12 months shall begin after building operation has stabilized.

~~**8.1.3 Input Data Sources**~~

~~**8.1.3.1 Typical Weather Year Simulation Results.** Gather the model output data listed in Section 5.7.3.3 for the proposed design *energy model*, as simulated with a typical meteorological year (TMY) weather file.~~

~~**8.1.3.2 Actual Weather Year Simulation Results.** Acquire an *actual meteorological year* (*AMY*) weather file for the comparison year, and resimulate the same *energy model* referenced in Section 8.1.3.1 with the *AMY* weather file. After performing the simulation, recompile the model outputs defined in Section 5.7.3.3.~~

~~**Exceptions to 8.1.3.2:**~~

1. ~~A representative *AMY* simulation weather file is not publicly or commercially available.~~
2. ~~The *energy model* input file or modeling software needed to resimulate the model is not freely available or provided to the *energy modeler* at the time of completing this *modeling cycle*.~~

~~**8.1.3.3 Weather Data**. Extract the hourly outdoor dry-bulb temperature data from the TMY and *AMY* weather files. If exempt from Section 8.1.3.2, obtain hourly outdoor dry-bulb temperature measurements for the comparison year as recorded at the building's *local weather station*.~~

~~**Exceptions to 8.1.3.3:**~~

1. ~~If hourly weather data for the *local weather station* are not available, daily average, maximum, and minimum data or data from a different weather station may be used.~~
2. ~~If the *energy modeler* determines the *local weather station* is not a good representation of the building's local weather conditions, data from a different weather station may be used.~~

~~**8.1.3.4 Energy Consumption and Demand Data.** Obtain monthly (30 ± 2 days) or shorter time interval *site energy* use, and, if applicable, energy cost data for the comparison year for all of the building *energy sources*. If available, also obtain peak energy demand measurements for each measurement period.~~

~~**Exception to 8.1.3.4:** The energy measurement interval may be longer than one month but shall not exceed 65 days.~~

~~**8.1.4 Analysis.** The analysis steps involving measured and simulated energy data shall be performed using the typical weather year simulation results. The same analysis shall also be performed using *actual weather year* simulation results, except where exceptions to Section 8.1.3.2 apply.~~

~~**8.1.4.1 Energy Data Alignment.** Align the measured and simulated energy data sets to correspond to the beginning and ending days of each calendar month.~~

~~**8.1.4.2 Energy Data Normalization.** Normalize the energy consumption for each aligned interval by dividing the value by the number of days in each interval and the building *gross floor area*.~~

~~**8.1.4.3 Typical and Actual Year Weather Metrics.** Calculate the following weather parameters for both the typical and actual comparison years.~~

~~**8.1.4.3.1** Average, maximum, and minimum dry bulb temperature for each month and the year.~~

~~**8.1.4.3.2** Heating degree days (HDD) and cooling degree days (CDD), using a common base temperature, for each month and the year.~~

~~**8.1.4.4 Modeling Uncertainty.** For each *energy source* and total energy use, calculate the following metrics to quantify the differences between measured and simulated (TMY, and if applicable *AMY*) data sets.~~

~~a. Normalized mean bias error (NMBE) as defined in ASHRAE Guideline 14[2]:~~

$$\text{NMBE} = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)}{(n-p)\times \bar{y}}$$

~~b. Coefficient of variation of the root mean square error (CVRMSE) as defined in ASHRAE Guideline 14:~~

$$\text{CVRMSE} = \frac{\sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{(n-p)}}}{\bar{y}}$$

~~where~~

~~y = measured energy use for each month~~

~~$\hat{y}$ = simulated (typical or actual year) energy use for each month~~

~~$\bar{y}$ = arithmetic mean of the measured monthly data~~

~~i = interval that the measured and simulated energy data are aligned to (such as monthly)~~

~~n = number of intervals (greater than 1) included in the analysis~~

~~p = 1~~

~~**8.1.4.5 Regression Analysis.** Use the ASHRAE Inverse Modeling Toolkit (IMT)[3] software or similar methodology to develop linear regression models that correlate energy use (by energy source) to outdoor air temperature, heating and cooling degree days, or other relevant independent variables. Develop regression models for both the measured and simulated (TMY and, if applicable, *AMY*) data sets, and, from these models, calculate or infer the following:~~

~~a. *Balance-point temperature* or *balance-point temperatures*~~
~~b. Annual base load energy use~~
~~c. Annual energy use associated with heating and/or cooling seasons~~
~~d. Uncertainty metrics defined in Section 8.1.4.4 for the regression models~~

~~**Exception to 8.1.4.5:** Regression analysis is required only if Section 8.1.4.5 is specifically adopted by the *AHJ*.~~

8.1.3 Analysis. Compliance with this *modeling cycle* shall use one of the following options:

a. Conduct a statistical analysis of energy use, and demand if available, as it relates to weather and/or one or more other independent variables for the simulated data.

Informative Note: The most common type of statistical analysis is a linear regression that relates energy to weather or other independent variables. Other independent variables are building-specific performance indicators that affect energy use and may include occupancy, patient days, or production totals. ASHRAE Guideline 14, *Measurement of Energy, Demand, and Water Savings*, provides guidance that may be used in this analysis.

1. Obtain the data for the independent variables during the collection period for the measured data.

2. Use the statistical analysis to calculate expected monthly (or other time step) energy usage and demand, if applicable, using weather or other independent variables from the measured data.

b. Use actual weather data for the design simulation.
   1. Acquire an *actual meteorological year (AMY)* weather file for the comparison year.
   2. Resimulate the last design- or construction-phase *energy model* with the *AMY* weather file after performing the simulation.
   3. Recompile the model outputs defined in Section 5.7.3.3.

8.1.3.1 Compare the calculated or simulated results to the measured data. Include the following:

a. Monthly (or other time step) energy use for each *energy source* individually and for all *energy sources* combined for the time step analyzed
b. Monthly (or other time step) peak energy demand for each *energy source* if available for the time step analyzed.
c. Annual site energy use and cost by source and total.

~~8.2~~8.1.4~~Cycle-Specific~~ Reporting

~~**8.2.1 Background Information**~~

In addition to the general reporting requirements in Section 5.7.3, report the following:

a. Definition of the comparison year
b. A brief description of the *modeling cycle* or phase of design/construction represented by the latest *energy model*
c. The geographic location of the TMY or *AMY* weather file~~The TMY weather file location~~
d. ~~The *AMY* weather file location or the~~ The name and geographic location of the building's *local weather station*
e. ~~A brief narrative describing differences between the simulated and actual building occupancy during the comparison year~~
~~f.~~e. The source of measured energy data
~~g.~~f. Any independent variables used in the analysis~~The floor area used to normalize energy data and costs~~

~~**8.2.2 Comparison of Actual and Typical Year Weather.** Provide graphical and/or tabular comparisons of the following actual and typical year weather conditions.~~

~~a. Monthly and annual average dry-bulb temperature~~
~~b. Monthly and annual heating and cooling degree days~~

~~**Table 1 Limits**~~

~~NMBE~~	~~±5%~~
~~CVRMSE~~	~~15%~~

~~**8.2.3 Comparison of Measured and Simulated Energy Performance.** Provide the following graphical and/or tabular comparisons of the normalized measured and simulated (TMY and, if applicable, *AMY*) data sets.~~

~~**8.2.3.1** Monthly and total annual energy use for each *energy source* individually and for all *energy sources* combined.~~

~~**8.2.3.2** Monthly and annual peak energy demand for each *energy source* if available.~~

~~**8.2.3.3** Annual *site energy* use and cost, by source and total, divided by the building floor area used in Section 8.1.4.2.~~

~~**8.2.3.4** An energy signature scatter plot, where the independent and dependent value (*x*-*y* coordinates) for each plotted point is defined as follows:~~

~~a. **Independent variable (*x*).** The average outdoor air temperature for the measured or simulated period.~~
~~b. **Dependent variable (y).** The normalized, total energy use for the measured or simulated period.~~

~~**8.2.4 Regression Analysis.** If Section 8.1.4.5 is completed, provide a graphical comparison of each regression model with its corresponding measured or simulated dataset. Additionally, provide a table summarizing the metrics defined in Section 8.1.4.5(a) through 8.1.4.5(d).~~

~~**8.2.5**~~**8.1.4 Narrative.** In addition to the general narrative requirements in Section 5.7.3.1,~~If the uncertainty metrics calculated in Section 8.1.4.4 exceed the limits listed in Table 1~~, prepare a short, qualitative narrative describing the following:

~~**8.2.5.1**~~a. How the measured and simulated ~~(TMY and, if applicable, *AMY*)~~ data sets differ.
~~**8.2.5.2**~~b. A list of possible reasons for the differences.
~~**8.2.5.3**~~c. Recommended next steps for resolving the differences or improving building energy performance.

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