
Public Review Draft

Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings

First Public Review (Dec 2023)

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ASHRAE, 180 Technology Pkwy NW, Peachtree Corners, GA 30092
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### NOTE

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FOREWORD

Standard 183 was created in a collaborative effort between ASHRAE and ACCA, the Air Conditioning Contractors of America. It establishes minimum requirements for performing peak cooling and heating load calculations for buildings except low-rise residential buildings. Although there are many methods available to perform peak cooling and heating load calculations, the intent of this standard is to establish a minimum level of requirements that is as inclusive of as many methods as possible while still being restrictive enough to mandate an appropriate level of care and accuracy. An accurate estimate of peak cooling or heating load requires not only that a sound method be used but also that inputs to the method are reasonable and realistic (the execution of the method).

The heat transfer interactions that occur outside and inside a conditioned building are complex and involve many interrelated variables. All load calculation methods therefore involve some level of simplification of the actual interactions among these variables to allow practical solutions to these very complex problems. The requirements in this standard that relate to the load calculation method are technical to the extent that they address these simplifications of the fundamental heat transfer interactions. If a method oversimplifies the problem, then an inaccurate load estimate can result. Complying with this standard requires knowledge of the underlying principles of the methods used and the techniques that these methods use to address the fundamental heat transfer interactions.

There is a distinction in this standard between zone load and system load. This standard is intended to address the calculation of zone load, but it is impossible to completely decouple the system load or capacity calculation from the zone load calculation. Systems and the processes to calculate their loads or capacities vary dramatically. Some aspects of the overall approach to systems are included in this standard, but the standard is not intended to be a comprehensive or detailed discussion of how to calculate system loads. Users of this standard are cautioned not to confuse zone heat gain with system sizing.

This is a reaffirmation of Standard 183-2007. This standard was prepared under the auspices of ASHRAE. It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interests of obtaining uniform guidelines throughout the industry. This 2020 reaffirmation includes editorial updates to Sections 3.2 and 4.1.

1. PURPOSE

This standard establishes requirements for performing peak cooling and heating load calculations for buildings except low-rise residential buildings.

2. SCOPE

This standard sets minimum requirements for methods and procedures used to perform peak cooling and heating load calculations for buildings except low-rise residential buildings.

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

3.1 Terms Defined in This Standard

beam solar: the component of solar radiation received from the sun without being scattered by the atmosphere or reflected by other surfaces.

building location: for purposes of load calculation, the building’s latitude and longitude or the country, state, and city.

convective heat gain: the portion of a heat gain that is transferred by convection to air inside a building.

cooling load: a general term used to refer to the sensible and latent cooling load of a zone or an HVAC system.

diffuse solar: the component of solar radiation composed of the sky diffuse and ground diffuse solar flux.
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- References were updated
**design conditions:** for outdoor conditions, the air temperature, humidity, and solar flux values used to calculate cooling and heating loads. For indoor conditions, the air temperature and/or humidity requirements for a zone or a building.

**diversity:** adjustments to internal heat gains made to account for the fact that the instantaneous heat output of all load-producing items (i.e., occupants, lighting, appliances, devices, equipment) is normally less than the maximum output for the same set of items. The instantaneous load is discounted for factors such as on-off cycles, occupancy schedules, duty cycles, and reduced power input.

**fenestration:** windows, skylights, and doors. Fenestration is typically composed of multiple components or assemblies, such as framing, glazing, dividers, and mullions.

**flux:** energy flow rate per unit surface area.

**ground diffuse solar:** the component of solar radiation received after being reflected by ground surfaces surrounding a building.

**heat gain:** the rate at which heat enters a surface, an airstream, or a zone. Heat gain is classified by its mode (convective or radiant) and by whether it is a sensible or latent gain. The radiant portion of heat gain becomes cooling load by a conversion process over time that causes a delay between the time the heat gain occurs and the time the heat is converted to cooling load.

**heating load:** for zones, the rate at which heat must be added to maintain indoor design conditions. For systems, the rate at which heat must be added to a transport fluid (air, water) to maintain indoor design conditions.

**incident solar flux:** the beam, sky diffuse, and ground diffuse solar flux received by fenestration and opaque building surfaces.

**infiltration:** the flow of outdoor air into a building through cracks and other unintentional openings and through normal use of exterior doors for entrance and egress.

**internal equipment:** equipment that is located in the zone or building and that generates heat (e.g., computers, copy machines, laboratory equipment, kitchen equipment, motors, factory machinery).

**internal heat gain:** heat that is generated from sources that are within the zone (e.g., people, lights, equipment).

**latent cooling load:** for zones, the rate at which moisture must be removed from the zone to maintain indoor design humidity. For systems, the rate at which heat is removed at a cooling coil or dehumidifying device in order to condense or remove moisture from the supply airstream or dehumidified space.

**latent heat gain:** an energy gain to a zone that occurs when moisture is added to the air in the zone.

**load factor:** the ratio of actual power use to rated or nameplate power for equipment. For example, equipment with a nameplate rating of 250 W may have a peak measured power of 180 W. In this example, an internal heat gain of 180 W should be used rather than 250 W for load calculations.

**low-rise residential:** single-family houses, multi-family structures of three stories or fewer above grade, and manufactured houses, which includes both mobile homes and modular homes.

**method:** a procedure used to calculate the cooling or heating load of a zone or building. Load calculation methods that comply with this standard include, but are not limited to:

a. the cooling load temperature difference/cooling load factor (CLTD/CLF) family of methods,

b. total equivalent temperature difference/time averaging (TETD/TA) methods,

c. transfer function methods (TFMs),

d. radiant time series (RTS) methods, and

e. heat balance (HB) methods.

**Informative Note:** Recommendations on how to choose a method are provided in Informative Appendix A.
**peak load:** the largest cooling load or heating load calculated based on design conditions.

**radiant heat gain:** the portion of a heat gain that is transferred by thermal radiation from the source of the heat gain to surfaces within the zone or the building.

**reheat:** heat used to raise the temperature of air after the air has been mechanically cooled. Reheat is often discouraged by energy codes.

**sensible cooling load:** for zones, the rate at which heat must be removed from the zone to maintain indoor design temperature. For systems, the rate at which heat is removed at the apparatus in order to reduce the temperature of the supply airstream.

**sensible heat gain:** an energy gain to a zone that occurs when heat is directly added to the zone through convection, conduction, and/or radiation.

**sky diffuse solar:** the component of solar radiation whose character has been changed by scattering in the atmosphere.

**solar heat gain:** energy from the sun that enters a zone through fenestration.

**thermal mass effect:** the ability of a material layer to store heat and the ability of an opaque envelope component to dampen and delay transfer of heat.

**time delay:** the time interval between heat transfer events in a zone or building.

**temperature-driven heat gain:** the heat gain or loss due to the difference between the indoor and outdoor temperatures.

**zone:** a room or space or group of rooms or spaces in a building.

**zone load:** the cooling load or heating load occurring in a zone.

### 3.2 Abbreviations and Acronyms

- HVAC: heating, ventilating, and air conditioning
- CLTD/CLF: cooling load temperature difference/cooling load factor
- HB: heat balance
- RTS: radiant time series
- TETD/TA: temperature difference/time averaging
- TFM: transfer function method

### 4. COMPLIANCE

4.1 Where validation of compliance with this standard is part of a permit or other review process, documentation shall be provided indicating that the method used, the assumptions, and the execution of the method meet the requirements of this standard.

**Informative Note:** The recommended format for this documentation is shown in Informative Appendix B.

4.2 The method shall utilize data and perform calculations in a manner that meets the requirements of this standard.

4.3 Inputs to a method shall be determined in a manner that meets the requirements of this standard.

### 5. WEATHER DATA AND INDOOR DESIGN CONDITIONS

5.1 Indoor design conditions shall be established by owner criteria, local codes, or comfort criteria.

5.2 Cooling calculations shall use values of outdoor air temperature and humidity for the building use, the building location, time of year, and time of day.

5.3 Solar radiation for cooling calculations shall use solar flux conditions for the building location, time of year, time of day, and orientation of the surface receiving the solar radiation.

5.4 Heating calculations shall use values of outdoor air temperature for the building use and the building location.
6. COOLING LOAD METHOD

6.1 The calculation method shall account for convective heat gain, radiant heat gain, and the thermal mass effect on cooling load.

6.2 The cooling load calculation shall address the hours of the day and months of the year necessary to establish the peak cooling load and the hour at which it occurs. The peak load may occur at any of a number of possible hours.

7. EXTERNAL HEAT GAINS

7.1 Fenestration

7.1.1 The calculation method shall account for both temperature-driven heat gain and solar heat gain.

7.1.2 The temperature-driven heat gain shall be calculated using the thermal performance of the entire fenestration assembly.

7.1.3 The solar heat gain shall be calculated from incident solar flux and the solar performance of the entire fenestration assembly.

7.1.4 The solar heat gain calculation shall account for interior shading from devices such as blinds, shades, or drapes when such devices are present.

7.1.5 The solar heat gain calculation shall account for exterior shading when present.

7.2 Opaque Building Envelope. The heat gain of opaque building envelope components shall account for solar radiation and temperature-driven heat gain, shall consider the thermal performance of materials in the opaque building envelope component, and shall consider the time delay occurring as heat is conducted through the material layers.

7.3 Infiltration. The calculation method shall account for separate sensible and latent infiltration heat gains when infiltration exists.

8. INTERNAL HEAT GAINS

8.1 Internal heat gains shall be included in the cooling load.

8.2 Sensible and latent heat gain components of all internal gain contributors shall be considered separately.

8.3 Evaluation of heat gains from the occupants shall take into account the number of occupants, their activity levels, and the occupancy schedule.

8.4 Evaluation of heat gains from lighting and internal equipment shall consider their operation schedules and load factors.

8.5 Evaluation of heat gains from lighting equipment shall account for heat transfer to the ceiling plenum (if applicable).

9. HEATING LOAD

9.1 Heating load calculations shall be based on peak temperature-driven heat loss through the building envelope.

9.2 Credit for solar heat gains and for internal heat gains shall not be included as part of the calculation of the peak heating load.

Exception to 9.2: Where constant or permanent internal heat gains are known to be present in the zone to be heated, the peak heating load may be adjusted to account for these available heat gains.

9.3 Infiltration shall be accounted for when it exists.

9.4 Heating load calculations shall account for cold processes or equipment in the zone that absorbs heat (for example, some refrigerated cases).

10. SYSTEM COOLING AND HEATING LOADS

10.1 Cooling and heating system loads shall account for the capacity required to accomplish psychrometric processes. Psychrometric processes include conditioning for reheat, dehumidification, humidification, and air mixing.
10.2 Energy from fans and pumps used in cooling systems shall be accounted for in system cooling loads.

10.3 Heat transfer through piping and ductwork walls shall be accounted for in determining system loads.

10.4 Duct leakage shall be considered in determining system load.

10.5 Outside air cooling and heating loads shall be calculated for the particular system configuration and weather data.

10.6 Diversity due to variations in actual occupancy, lighting, or equipment use shall be considered in determining system cooling loads.

10.7 Based on the specific type of system designed, the system cooling and heating loads shall account for inherent system inefficiencies such as damper leakage.
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INFORMATIVE APPENDIX A

CHOICE OF METHODS

Modeling the heat interactions in a building is complex, often involving many interrelated variables. It would be impossible for practical calculations to address all interactions explicitly. All load calculations, therefore, involve varying levels of simplification of the fundamental interactions. Simplified methods are not necessarily less accurate. In fact, according to the 2017 ASHRAE Handbook—Fundamentals,

the accuracy of cooling load calculations in practice depends primarily on the availability of accurate information and the design engineer’s judgment in the assumptions made in interpreting the available data. Those factors have much greater influence on a project’s success than does the choice of a particular cooling load calculation method. (Chapter 18)

This statement is valid for all simplified load calculations, whether for heating or cooling. It should be noted, however, that simplified methods inherently involve more simplifications and fixed assumptions than more rigorous methods. If the building or zone in question has components that match the embedded assumptions of a simplified method, then the method can be used to obtain an accurate result. On the other hand, if the components do not match the assumptions that were made in deriving the simplified method, then the results may not be accurate. With any method—but in particular with more simplified methods—it is important to understand the specific assumptions that are embedded and whether these approximate the building being considered.

This standard includes a specific reference to five commonly known load calculation methods (see Section 3, Definitions, Abbreviations and Acronyms). These specific methods are indicated as examples and are not intended to be an exclusive list. It is expected that newer and hopefully better methods will continue to be developed. New methods or existing methods that are not specifically referenced are able to meet the requirements of this standard as long as they properly consider the load elements described in this standard.

Many methods can be practically executed only by using a computer, but it is recognized that manual methods have a place in the industry as well. Computerized methods can quickly check all hours in a year to identify the specific time of the peak cooling load for each building and/or individual zone. When applying a manual method, it is not practical to perform every iteration to check all hours for all zones. The peak hours can usually be determined by applying applicable experience and professional judgment to check a limited number of hours. If the time of the peak cooling load is not properly identified due to poor judgment or an insufficient number of iterations, then a significant error could result.
INFORMATIVE APPENDIX B
RECOMMENDED ASHRAE/ACCA COMPLIANCE FORM FOR STANDARD 183

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- ☐ CLTD/CLF—Cooling Load Temperature Difference/Cooling Load Factor methods
- ☐ HB—Heat Balance methods
- ☐ TETDITA—Total Equivalent Temperature Difference/Time Averaging methods
- ☐ TFM—Transfer Function Methods
- ☐ RTS—Radiant Time Series methods
- ☐ OTHER (please specify) _________________________________

The undersigned attests that the above information is correct and that the procedures used to perform the load calculations comply with ANSI/ASHRAE/ACCA Standard 183.

Signed: _________________________________

Date: _________________________________

Submitted by: _________________________________

Date: _________________________________
POLICY STATEMENT DEFINING ASHRAE'S CONCERN
FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its Handbook, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.
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