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6.3 Thermal Blocks

A thermal block is a space or collection of spaces having similar space-conditioning requirements and is the basic thermal unit used in modeling the building. A thermal block can include more than one HVAC zone, but HVAC zones are not split between thermal blocks.

6.3.1 General Information

Thermal Block Name	
Applicability	All projects
Definition	A unique identifies for the thermal block
Units	Text
Input Restrictions	None
Baseline Rules	Not applicable
Thermal Block Description	
Applicability	All projects
Definition	A brief description of the thermal block that identifies the spaces and/or zones that are included or other descriptive information. The description should tie the thermal block to the building plans.
Units	Text
Input Restrictions	None
Baseline Rules	Not applicable
Thermal Block Type	
Applicability	All projects
Definition	Designation of the thermal block as directly conditioned space, indirectly conditioned space (i.e., conditioned only by borrowed heating or cooling from an adjacent thermal block), or plenum (i.e., unoccupied but partially conditioned as a consequence of its role as a path for returning air).
Units	List: directly conditioned, indirectly conditioned, unconditioned or plenum
Input Restrictions	The default thermal block type is “directly conditioned.”
Baseline Rules	The descriptor is identical for proposed and baseline building designs.
System Name	
Applicability	All projects
Definition	The HVAC system name of the system that serves this thermal block.
Units	Text, unique
Input Restrictions	None
Baseline Rules	The baseline may have a different system mapping if the baseline building has a different HVAC type than the proposed design.
Occupancy Type	
Applicability	All projects
Definition	One of three occupancy categories used in determining the baseline building envelope requirements. The three categories are residential, nonresidential, and semi-heated.
Units	List: residential, nonresidential, or semi-heated
Input Restrictions	The input is derived from the building classification or from the classification of the spaces that make up the thermal block.
Baseline Rules	Same as the proposed design
Floor Area	
Applicability	All projects
Definition	The gross floor area of a thermal block including walls and minor spaces for mechanical or electrical services, such as chases, that are not assigned to other thermal blocks; larger mechanical spaces and electrical rooms should not be combined. User input of floor areas of individual thermal blocks should be accurate to within 5% of actual, while user inputs of gross building areas should be accurate to within 2% of actual when measured to the outside surface of exterior walls.
Units	Square feet (ft^2)
Input Restrictions	The floor area of the thermal block is derived from the floor area of the individual spaces that make up the thermal block.
Baseline Rules	Identical to the proposed design

6.3.2 Interior Lighting

Inputs for interior lighting are specified at the space level (see specification below). In those instances when thermal blocks contain just one space, the inputs here will be identical to the inputs for the single space that is contained within the thermal block.

For those instances when a thermal block contains more than one space, the software shall either model the lighting separate for each space and sum energy consumption and heat gain for each time step of the analysis or it must incorporate some procedure to sum inputs or calculate weighted averages such that the lighting data used at the thermal block level is equal to the combination of lighting data for each of the spaces contained in the thermal block.

In some cases, combining lighting data at the space level into lighting data for the thermal block may be challenging and would have to be done at the level of each time step in the simulation. These cases include:

- A thermal block that contains some spaces that have daylighting and others that do not.
- A thermal block that contains spaces with different schedules of operation.
- A thermal block that contains some spaces that have a schedule adjusted in some way for lighting controls and other spaces that do not.
- Combinations of the above.

6.3.3 Receptacle and Process Loads

Inputs for receptacle and process loads are specified at the space level (see specification below). In those instances when thermal blocks contain just one space, the inputs here will be identical to the inputs for the single space that is contained within the thermal block.

For those instances when a thermal block contains more than one space, the software shall either model the receptacle and process loads separate for each space and sum energy consumption and heat gain for each time step of the analysis or it must incorporate some procedure to sum inputs or calculate weighted averages such that the receptacle and process loads used at the thermal block level are equal to the combination of receptacle and process loads for each of the spaces contained in the thermal block.

When the spaces contained in a thermal block have different schedules, combining receptacle and process loads from the space level may be challenging and would have to be done at the level of each time step in the simulation. See discussion above on lighting.

6.3.4 Occupants

Inputs for occupant loads are specified at the space level (see specification below). In those instances when thermal blocks contain just one space, the inputs here will be identical to the inputs for the single space that is contained within the thermal block.

For those instances when a thermal block contains more than one space, the software shall either model the occupant loads separate for each space and the heat gain for each time step of the analysis or it must incorporate some procedure to sum inputs or calculate weighted averages such that the occupant loads used at the thermal block level are equal to the combination of occupant loads for each of the spaces contained in the thermal block.

When the spaces contained in a thermal block have different occupant schedules, rolling up occupant loads from the space level may be challenging and would have to be done at the level of each time step in the simulation. See discussion above on lighting.

6.3.5 Infiltration

Infiltration Method	
Applicability	All projects
Definition	Energy simulation programs have a variety of methods for modeling uncontrolled air leakage or infiltration. Some procedures use the effective leakage area which is generally applicable for small residential scale buildings. The component leakage method requires the user to specify the average leakage through the building envelope per unit area (ft²). Other methods require the specification of a maximum rate, which is modified by a schedule.
Units	List: effective leakage area, component leakage, air changes per hour, or other method supported by the energy analysis software.
Input Restrictions	For the purpose of federal tax credits, a fixed infiltration rate shall be specified and calculated as a leakage per area of exterior envelope, including the gross area of exterior walls, roofs, and exposed floors, but excluding slabs on grade and interior partitions. For green building ratings and Design to Earn ENERGY STAR, the default method is the component leakage method, however, there are no restrictions on other reasonable methods.
Baseline Rules	The infiltration method used for the proposed design shall be used for the baseline building.

Infiltration Data	
Applicability	All projects
Definition	Information needed to characterize the infiltration rate in buildings. The required information will depend on the infiltration

method selected above. For the effective leakage area method, typical inputs are leakage area in ft² or other suitable units and information to indicate the height of the building and how shielded the site is from wind pressures. The air-changes per hour (ACH) method requires an estimate of the ACH and a schedule which modifies the ACH for various periods during the year. Similar data would be specified for the leakage per component area method. Only zones with exterior wall area are assumed to be subject to infiltration.

Units	A data structure is required to define the effective leakage area model, while a single numeric value can define the ACH or the leakage per area of exterior envelope method.
Input Restrictions	For the purpose of federal tax credits, infiltration shall be equal to 0.038 times the gross wall area exposed to ambient outdoor air. For green building ratings and Design to Earn ENERGY STAR, any reasonable inputs may be specified, consistent with the chosen infiltration modeling method. Acceptable ranges for inputs should be defined for each method supported by rating software.
Baseline Rules	The infiltration data for the baseline building shall be the same as the proposed design unless the proposed design employs specific measures that go beyond the mandatory measures specified by the baseline standard. When credit is taken for reductions in infiltration (see above), test results or research reports shall be provided that document and support the inputs used for the baseline building and the proposed design.

Infiltration Schedule

Applicability	When an infiltration method is used that requires the specification of a schedule
Definition	With the ACH method and other methods (see above), it may be necessary to specify a schedule that modifies the infiltration rate for each hour or time step of the simulation. Typically the schedule is either on or off, but can also be fractional.
Units	Data structure: schedule, fractional
Input Restrictions	For the purpose of federal tax credits, the infiltration schedules from Appendix C, Tables 12 through 16 shall be used. The infiltration method and rate (see above) are also specified. For green building ratings and Design to Earn ENERGY STAR, the default infiltration schedule is 1.0 (100% of specified infiltration rate for periods of time when the fans serving the thermal block are not operating and a zero [no infiltration] for periods of time when the fans are operating). This is based on the assumption that the fans pressurize the space and that the impact of introducing outside air into the thermal block is accounted for in the operation of the HVAC system.
Baseline Rules	The infiltration schedule for the baseline building shall be the same as the proposed design.

6.3.6 Natural Ventilation

Natural ventilation may be modeled for a thermal block in the proposed design when the following conditions are met:

- The thermal block does not have an air conditioning system.
- The temperature of the thermal block does not exceed the cooling setpoint temperature for more than 300 hours for the year of the simulation with just the natural ventilation system operating.

Under these circumstances, the thermal block in the proposed design is modeled with no air conditioning when the natural ventilation system maintains temperature. For periods when the space temperature is greater than the cooling setpoint, an air conditioner like the one for the baseline building is assumed to operate to maintain temperature. The fans in this simulated system cycle with loads. The corresponding thermal block in the baseline building is modeled with air conditioning and the fans operate continuously.

Natural Ventilation Method

Applicability	All thermal blocks with natural ventilation
Definition	The method used to model natural ventilation. The choices will depend to some extent on the capabilities of the energy simulation program. One procedure that could be used with most energy simulation programs would be to approximate the effect of natural ventilation by scheduling a high rate of infiltration when conditions are right. The schedule would typically be developed through computational fluid dynamic software or with other software that is capable of estimating the cooling benefit of natural ventilation and relating it to climate so that the schedule can be developed.
Units	List: choices depend on the capabilities of the energy simulation program.
Input Restrictions	None
Baseline Rules	Baseline building is not modeled with natural ventilation.

Air Flow Rate

Applicability	All projects with natural ventilation that use a method that require the specification of an air flow rate
Definition	The rate of air flow through the thermal block when the natural ventilation system is operating
Units	Air changes per hour or cfm
Input Restrictions	The air flow rate for the proposed design shall be determined using sound engineering methods and supporting documentation shall be provided.
Baseline Rules	Baseline building is not modeled with natural ventilation.

Natural Ventilation Schedule

Applicability	All projects with natural ventilation that use a method that requires a schedule
Definition	A schedule that modifies the airflow rate through the thermal block dictates when windows can be opened to provide natural ventilation.

Units	Data structure: schedule, fractional
Input Restrictions	The schedule for the proposed design shall be determined using sound engineering methods and keyed to outdoor temperature and perhaps other conditions on the weather file used for the simulation.
Baseline Rules	The baseline building is not modeled with natural ventilation.

6.3.7 Thermal Mass

This set of building descriptors characterize the thermal mass that is not explicitly captured by the definition of exterior surfaces and/or interior partitions.

Thermal Response Characteristics

Applicability	All projects
Definition	This building descriptor only addresses the building contents. The thermal mass associated with floors, interior walls, and other building envelope components is derived from the thermal properties and materials that make up these components. However, if interior partitions are not explicitly entered (see below) their effect may be captured with this input. The thermal capacitance of the building contents are typically specified in terms of the composite weight of the building contents in lb/ft² or absolute weight in lb. In this instance, the software assumes an average specific heat for the contents. This input can also be specified as the mass of the contents multiplied times the specific heat of the contents. The latter method would be a summation, since each item may have a different specific heat.
Units	lb/ft² or lb
Input Restrictions	Any reasonable inputs, consistent with the proposed design and the method used by the simulation program to model interior thermal mass
Baseline Rules	The interior thermal mass in the baseline building shall be the same as the proposed design.

Furniture and Contents

Applicability	All projects
Definition	A specification of the mass and heat capacity of furniture and other elements in the interior of the building. This includes information about the coverage and weight of furniture in the space as well as how much of the floor is covered by furniture. The latter affects how much of the solar gains that enters the space is directed to the floor with delayed heat gain and how much becomes a more instantaneous load.
Units	Data structure
Input Restrictions	Any reasonable inputs, consistent with the proposed design and the method used by the simulation program to model interior thermal mass.
Baseline Rules	The interior thermal mass and modeling assumptions in the baseline building shall be the same as the proposed design.

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