SECTION 409
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

C409.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis. 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 thermal block including those zones shall not be included in the model.
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C409.5.3.1 Compliance Report Building permit submittals shall include:
1. A report produced by the simulation software that includes the following:
1.1 Address of the building.
1.2 Name of individual completing the compliance report.
1.3 Name and version of the compliance software tool
1.4 The dimensions, floor heights and number of floors for each thermal block.
1.5 By thermal block, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for
each fenestration component.
1.6 By thermal block or by surface for each thermal block, the fenestration area.
1.7 By thermal block, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment
efficiencies and system controls.
1.8 Annual site HVAC energy use by end use for the proposed and baseline building.
1.9 Annual sum of heating and cooling loads for the baseline building.
1.10 The HVAC total system performance ratio for both the standard reference design and the proposed design.
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4. Floor plan of the building identifying:
4.1 How portions of the buildings are assigned to the simulated thermal blocks.
4.2 Areas of the building that are not covered under the requirements of Section C403.1.1.
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C409.6.1.1 Thermal block Geometry. The geometry of buildings shall be configured using one or more thermal blocks. Each thermal block shall define attributes including thermal block dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent thermal 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 thermal block shall match the proposed design within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.

4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional thermal blocks may be necessary to meet these requirements. 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 thermal block geometry and HVAC system assignment to thermal blocks are met with appropriate assignment to thermal zones.

Exception: Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

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C409.6.1.1.1 Number of thermal blocks One or more thermal blocks may be required per building based on the following restrictions:

1. Each thermal block can have only one occupancy type (multifamily dwelling unit, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single thermal block shall be created for each unique use type.
2. Each thermal block can be served by only one type of HVAC system. Therefore, a single block shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one thermal block. Table D601.10.2 provides directions for combining multiple HVAC units or components of the same type into a single block.
3. Each thermal block can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique thermal blocks should be created for the floors with varying heights.

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C409.6.1.2 Thermal Zoning Each floor in a thermal block shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal block. If any facade in the thermal block is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each facade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

C409.6.1.3 Occupancy Building occupancies modeled in the standard reference design and the proposed design shall comply with the following requirements.

C409.6.1.3.1 Occupancy Type. The occupancy type for each thermal block shall be consistent with the building area type as determined in accordance with Section C405.4.2.1. Portions of the building that are building area types other than multifamily dwelling unit, multifamily common area, office, school (education), library, or retail shall not be included in the simulation.

Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.

C409.6.1.3.2 Occupancy schedule, density, and heat gain The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C409.6.1.4 Envelope Components. Building envelope components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.

C409.6.1.4.1 Roofs Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single thermal block, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.

C409.6.1.4.2 Above grade walls. Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the facade of a thermal block an area-weighted U-factor shall be used.

C409.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a thermal block, an area-weighted C- factor shall be used.

C409.6.1.4.4 Above grade exterior floors. Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the thermal block an area-weighted U-factor shall be used.

C409.6.1.4.5 Slab on grade floors. The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a thermal block, an area-weighted F- factor shall be used.

C409.6.1.4.6 Vertical Fenestration The window area and area weighted U-factor and SHGC shall be modeled for each façade based on the proposed design. Each exterior surface in a thermal block must comply with Section C409.6.1.1.1 item 5. Windows will be combined into a single window centered on each facade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

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C409.6.1.10.2 Proposed building HVAC system simulation The HVAC systems shall be modeled as in the proposed design at design conditions unless otherwise stated with clarifications and simplifications as described in Tables C409.6.1.10.2(1) and C409.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a thermal block shall be served by the same HVAC system type as described in Section C409.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled. Table C409.6.1.10.2(1) Proposed Building System Parameters 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 parameter to vary. 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.

Where multiple system components serve a thermal block, average values weighed by the appropriate metric as described in this section shall be used.

1. Where multiple fan systems serve a single thermal block, fan power shall be based on
weighted average using the design supply air cfm
2. Where multiple cooling systems serve a single thermal block, COP shall be based on a
weighted average using cooling capacity. DX coils shall be entered as multistage if more than 50 percent of coil capacity serving the thermal block is multi-stage with staged controls.
3. Where multiple heating systems serve a single thermal block, thermal efficiency or
heating COP shall be based on a weighted average using heating capacity.

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TABLE C409.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS

Average minimum terminal unit airflow percentage for thermal block weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.	
Percent of thermal block floor area under occupied standby controls, ON/OFF only with occupancy sensor and no variable control	
Percentage of thermal block floor area under variable DCV control (CO2); may include both variable and ON/OFF control	

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C409.6.2.2 Thermal blocks Same as proposed design.