Seattle Department of Construction and Inspections

Tip 423

Seattle Permits

— part of a multi-departmental City of Seattle series on getting a permit

Energy Compliance Though the Target Performance or Total Building Performance Paths

June 29, 2018

This Tip answers frequently asked questions on how you can meet the Seattle Energy Code requirements though the Total Building Performance and Target Performance compliance pathways. This Tip is not a comprehensive compliance guide.

Background

New commercial construction projects in Seattle can comply with the 2015 Seattle Energy Code (SEC) through one of three pathways:

- Prescriptive Path (includes C402.1.5 Component Performance Alternative)
- Total Building Performance Path (C407)
- Target Performance Path (C401.3)

The Total Building Performance and the Target Performance paths each require whole building energy modeling. The Total Building Performance Path uses only modeled performance to show code compliance. The Target Performance Path also uses energy modeling to demonstrate that the proposed design is capable of hitting the operational performance target, but in addition, this path requires that the actual measured building energy consumption meets the target.

General FAQs

What is Total Building Performance?

Total Building Performance, SEC Section C407, describes the procedure used to compare a proposed design to the standard reference design. The proposed design energy model's annual energy consumption must be less than or equal to 87%, 90%, or 93% of the standard reference design energy model's energy consumption, depending on whether you use additional efficiency packages options from SEC Section C406.

How do I apply Section C406 – Additional Efficiency Package Options?

New to the 2015 energy code is Section C406, Additional Efficiency Package Options. For prescriptive compliance, you are required to include two of the eight energy efficiency options discussed in more detail later in this Tip. For C407 Total Building Performance Path compliance, you can either include the C406 additional efficiency options in the proposed building model, or exclude them and use a more stringent energy modeling target. For Target Performance Path compliance, you don't have to include C406 options. See the "C406 Measures" section below under C407 FAQs for more information.

What is the Target Performance Path (C401.3)?

The Seattle Energy Code includes a novel outcome-based path for compliance called the Target Performance Path (TPP), introduced in the 2012 code cycle, that is described in SEC Section C401.3. Under the TPP, you have to provide utility bills to prove that your building's actual energy use meets a specific Energy Use Intensity target. The TPP gives you increased design freedom, in exchange for your commitment to demonstrate actual energy efficiency. You would have to pay a financial penalty if you did not meet your target.

Why choose the Total Building Performance Path or Target Performance Path?

You would typically use one of these pathways when the design of a project makes prescriptive compliance impractical. Common examples include:

700 5th Avenue, Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 684-8600

- Buildings with a glazing area greater than 40% of façade area
- Buildings without air economizer
- Dedicated Outdoor Air System (DOAS) is required but not provided in the building

	Total Building Performance	Target Performance Path
Mandatory Requirements	More mandatory requirements	Fewer mandatory requirements
Required Performance	Modeled energy use is 7-13% lower than the Standard Reference Design	Operating energy use is lower than the energy target, based on the building type
Energy Modeler Qualifications	None	2 years' experience plus PE or BEMP
Required Energy Models	Standard Reference Design and Proposed Design	Proposed Design Only
Sensitivity Analysis	Not required	Required
Compliance Report	Per Appendix E of the SEC	Per Appendix E plus C401.3.4 of the SEC
Financial Security	None	Required per SEC C401.3.11
Demonstration of Operating Energy Use	None	Annual EUI target achieved for a 12-month period, in the first 3 years of occupancy

Don't Forget about Mandatory Requirements!

Projects using the Total Building Performance Path or Target Performance Path must also comply with a number of mandatory requirements. SEC Section C401.2, item #2 lists mandatory measures for the Total Building Performance Path, while Section C401.3.3 lists mandatory measures for the Target Performance Path. Examples of these measures include air barrier testing, HVAC controls, solar readiness, and many more.

Required Documentation

For Total Building Performance Path or Target Performance Path modeling, you must submit a written report that includes the information outlined in Appendix E of the 2015 Seattle Energy Code. Include your report with the permit drawing sets (architectural, electrical, mechanical, etc.) that document key savings items. You cannot claim savings in the energy model for strategies that aren't included in the permit drawings, so if you take credit for lighting in the energy model, the electrical permit must be approved before the permit can be issued. The Target Performance Path report must also include a sensitivity analysis as stated in Section C401.3.4.

Tenant Versus Core & Shell Spaces

We often issue "core & shell" building permits before the tenant space designs are complete. In such cases, the core & shell project must meet the Total Building Performance or Target Performance Path requirements without depending on undefined tenant systems. You need to indicate the proposed terminal systems for core and shell mechanical systems, and include these terminal systems in the energy model. You must substantiate any other savings for tenant space measures (e.g. lighting) on your permit drawings that accompany the energy model report. You can't use tenant lease agreements to substantiate tenant energy savings.

Pre-submittal meetings

Pre-submittal meetings are an opportunity for the design team to ask the SDCI energy/ mechanical reviewer specific questions. You should document the questions and issue resolutions in your meeting notes and ask the SDCI energy/mechanical reviewer to review and approve your notes. Common topics for discussion include the selection of reference model HVAC systems as well as any unique situations or code clarifications. Include the approved notes in your Total Building Performance or Target Performance Path report.

Total Building Performance Path (C407) FAQs

Below are frequently asked questions regarding Total Building Performance energy modeling, in five categories:

- Envelope
- Mechanical
- Electrical
- Renewables
- C406 Additional Efficiency Options

Envelope

How do I determine whether to use Column A or Column B envelope values from Table C402.4 in the Standard Reference Design (SRD) model?

You should always use envelope values from Column A in the (SRD) unless your proposed design meets one of the criteria listed in exception 1 of Section C402.4. If your proposed design meets one of the exception 1 criteria, you can use Column B envelope values in the SRD. (See Director's Rule 9-2018, and Tables C407.5.1(1), C407.5.1(3), and C407.5.1(4) at the end of this Tip.)

Table C407.5.1(1) references 3% for maximum SRD skylight area, but Section C402.4.1 states 5% as maximum prescriptive skylight area. Which of these percentages is correct?

Our intent was to limit the skylight area to 5% of the gross roof area. The 3% indicated in Table C407.5.1(1) was an editing error.

Do I have to submit NFRC reports for glazing?

No. Submitting an NFRC simulation report is just one option. Alternatively, you can provide an NFRC Component Modeling Approach (CMA) bid report. Refer to Tip 403, "NFRC Labeling Requirements, 2015 Seattle Energy Code," for more detail.

Mechanical

How do I select the Standard Reference Design (SRD) heating type?

The SRD cooling and heating types should be determined using Tables C407.5.1(2), (3), and (4) in Director's Rule 9-2018 as applicable to your project.

The Column B heating type, and footnotes m, n, and o, from Table C407.5.1(4) have been deleted in Director's Rule 9-2018. We made this change to align the C407 Standard Reference Design with available prescriptive options.

Is there a maximum ventilation rate for the Standard Reference Design?

If the SRD requires a Dedicated Outdoor Air System (DOAS) and thus requires energy recovery compliant with C403.5.1, then there is no ventilation maximum for the SRD. If energy recovery is not provided, then use the maximum ventilation rate from Section C403.2.

For buildings governed by the Dedicated Outdoor Air System (DOAS) requirement in Section C403.6 of the 2015 SEC, how do I determine the reference model system if the DOAS and the terminal units in the proposed design have different cooling and heating sources?

The DOAS in the reference model should not have heating or cooling coils, only an Energy Recovery Ventilator (ERV) (see note k following Table C407.5.1(4)). Use the proposed design terminal heating and cooling sources to determine the reference model terminal heating and cooling type via Table C407.5.1(2).

Does the Standard Reference Design DOAS include heating and cooling?

No. The DOAS only has an energy recovery ventilation system with no bypass (see note k following Table C407.5.1(4)).

Is the process for selecting the SRD system through the HVAC system map applied only to the dominant system in the proposed model or is the system selection process applied to every proposed system, including secondary systems?

You should use the SRD system selection process for each unique system in your proposed design. Each unique proposed system should have an associated SRD system selected through the HVAC system maps.

For projects vested before October 1, 2018 (the effective date of Director's Rule 9-2018), how is fan operation and fan coil speed control treated per footnotes i and j of Table C407.5.1(4) for the Standard Reference Design for residential dwelling and sleeping units?

For residential dwelling and sleeping unit HVAC systems, footnote i determines the operation of the HVAC unit as either continuous or intermittent based on the proposed design. For example, if the proposed design is provided continuously (at the low Seattle Mechanical Code ventilation rate) then the Reference Design HVAC unit would operate continuously with fan speed control per footnote j. Footnote j determines whether the Reference Design HVAC system fan is required to operate with one-speed or two-speed control based on the requirements of SEC Section C403.2.11.5. For example, if the Reference Design HVAC unit is a DX PTHP or WSHP that is less than 65,000 BTUH, then the Reference Design would operate as a single speed fan for all modes of HVAC operation even if the proposed HVAC system uses multiple fan speed settings for ventilation or space conditioning.

For projects vested after October 1, 2018, how is ventilation and heating/cooling treated in the Standard Reference Design for Residential Dwelling and Sleeping Units?

For residential dwelling and sleeping unit HVAC systems, the ventilation system and heating/cooling system will be modeled in the reference model per footnote p of Table C407.5.1(4). The proposed mechanical ventilation system as designated in Section 403.4.5 – 403.4.9 of the Seattle Mechanical Code will determine the reference model ventilation and heating/cooling system and operation. The ventilation air will be supplied in parallel with the heating/cooling system for both the whole-house exhaust and the supply fan system baselines. See the table below for a detailed summary of how to model the reference model HVAC system based on the proposed system.

Residential Dwelling and Sleeping Unit Standard Reference Design Modeling Summary Table (Effective October 1, 2018)

Seattle Mechanical Code (SMC) Ventilation System	Examples of Proposed Mechanical Design	Corresponding Section C407 Baseline System Guidance	Available Sources of Section C407 Modeled Energy Savings
Whole house ventilation with exhaust fan systems (SMC 403.4.6)	■ Operable openings plus whole house exhaust fan running continuously at low airflow or running intermittently at high airflow per the SMC and terminal H/C unit that cycles on load ■ Operable openings plus a central exhaust fan running continuously at low airflow or running intermittently at high airflow per SMC and terminal H/C unit that cycles on load	■ Fan power: Whole house exhaust fan gets 1.4cfm/watt and terminal H/C unit gets 0.3 watt/cfm fan power allowance. ■ Fan operation: Exhaust fan runs continuously or intermittently at same ventilation rate and schedule as proposed. Ventilation is provided in parallel with heating and cooling. Terminal H/C unit cycles on load. ■ Terminal H/C unit: Per C407.5.1(3) systems map ■ Terminal H/C fan speed control: Per C403.2.11.5 ■ Energy or Heat recovery: Not required in SRD (because there isn't a central supply) ■ Make-up air: Additional infiltration airflow is modeled to provide "trickle vent" make-up outside air for whole house exhaust.	■ Fan power: More efficient whole house exhaust fan or terminal H/C fan ■ Fan operation: Per proposed design ■ Terminal unit H/C: Savings from more efficient cooling and heating or better envelope ■ Terminal H/C fan speed control: May take credit for two-speed fan control during cycling H/C operation when it's not required by C403.2.11.5 ■ Energy or Heat recovery: By definition, no energy or heat recovery in proposed design, so no opportunity for savings ■ Make-up air: Same as proposed design
Whole house ventilation integrated with forced-air systems (SMC 403.4.7)	Outside air ducted to return of terminal HVAC unit with the unit running continuously at low airflow or running intermittently at high airflow per the SMC (may or may not include an additional whole house exhaust fan to draw air through terminal HVAC unit)		

Seattle Mechanical Code (SMC) Ventilation System	Examples of Proposed Mechanical Design	Corresponding Section C407 Baseline System Guidance	Available Sources of Section C407 Modeled Energy Savings
Whole house ventilation with supply fan systems (SMC 403.4.8)	Central or unit- by-unit supply fan delivering outside air continuously at low airflow or intermittently at high airflow per the SMC in parallel or series with terminal H/C unit (Note: the difference between forced air and supply fan is that forced air has one fan while supply fan has two fans.)	■ Fan power: The outside air supply fan gets a "For all other systems, including DOAS" fan power allowance and the terminal H/C unit gets 0.3 w/cfm. There is no additional whole-house fan allowance. ■ Fan operation: The outside air supply fan runs continuously or intermittently at same ventilation rate and schedule as proposed. Ventilation is provided in parallel with heating and cooling. The terminal H/C supply fan cycles on load. ■ Terminal H/C unit: Per C407.5.1(3) systems map ■ Terminal H/C fan speed control: Per C403.2.11.5 ■ DOAS unit H/C: Un-tempered outside air (no H/C) ■ Energy or Heat recovery: Not required in SRD (because SRD does not have a central exhaust system and therefore complies with Section C403.5 Exception 9)	■ Fan power: More efficient DOAS supply fan or H/C fan ■ Fan operation: Per proposed design ■ Terminal H/C unit: Savings from more efficient cooling and heating or better envelope ■ Terminal H/C fan speed control: May take credit for two-speed fan control during cycling H/C operation when it's not required by Section C403.2.11.5 ■ DOAS unit H/C: Savings from more efficient cooling and heating systems ■ Energy or Heat recovery: Opportunity for savings from central energy recovery
Whole house ventilation with energy or heat recovery ventilation systems (SMC C403.4.9)	■ Central DOAS with energy or heat recovery delivering outside air continuously at low airflow or intermittently at high airflow per SMC in parallel or series with terminal H/C units ■ Unit-by-unit DOAS with energy or heat recovery delivering outside air continuously at low airflow or intermittently at high airflow per SMC in parallel or series with terminal H/C units		

Does the fan power, calculated using the brake horse power allowance and fan motor efficiency in Section C405.8, include DOAS fan power in the Standard Reference Design? Or is DOAS fan power modeled separately, in addition to the terminal fan power in the SRD?

According to the "fan systems" section in Table C407.5.1(1), systems 5, 6, 7, 8, and 10 (which are all DOAS systems with terminal units) get a fan power allotment of 0.3 w/cfm for the terminal unit. Additionally, the DOAS gets a fan power allotment equal to Pfan, defined in Table C407.5.1(1).

Is the reference model DOAS a constant or variable air volume system?

Per Table C407.5.1(4), the DOAS in the reference model is constant volume. Do not include demand control ventilation in the reference model, as it complies with Section C403.5.1 (energy recovery), an allowable exception to Section C403.2.6.2 regarding demand-controlled ventilation.

How do I choose my reference heating system type when I have mixed fuel sources (e.g. a heating hot water plant with both heat pumps and fossil fuel boilers)?

Per footnote b of Tables C407.5.1(2) and C407.5.1(3), use the primary fuel source (the fuel source with more than 50 percent capacity) to determine the Standard Reference Design HVAC system type. You should model the secondary heating source in the reference model with

the minimum allowed efficiency for that fuel type (80-82 percent for fossil fuel heating and 100 percent for electric). Model the secondary heating source in the proposed model as designed. The capacity ratio in the proposed model should match the capacity ratio in the reference model (e.g. if there is 20 percent heat pump capacity in the proposed model, the reference model should have 20 percent electric capacity). Exclude redundant (n+1) heating equipment in the capacity determination, but include the capacity required below certain temperature thresholds. Stage the SRD model heating sources in the same manner as for the proposed model; or model the entire reference model plant using the more efficient fuel type.

If you have an entirely separate system that uses a different fuel type, then separately run that system through the appropriate Table C407.5.1(2) or (3).

Electrical

For multifamily residential buildings pursuing Total Building Performance and using the Space-by-Space lighting method, there is no "Dwelling Unit" space type in Table C405.4.2(2). How should the Proposed Design and Standard Reference Design models treat lighting? Can the Proposed Design take credit for hard-wired fixtures?

Both the Standard Reference Design and Proposed Design models should use the lighting power allowances for Multifamily in the Building Area Method Table C405.4.2(1) for residential units. Do not take credit for lighting in residential units, even if efficient hardwired fixtures are part of the Proposed Design. High-rise residential projects should use appropriate lighting schedules such as the ENERGY STAR multifamily high-rise program schedule that totals to 2.34 equivalent full load hours.

Can the project take credit for lighting designs without the submission of lighting permit drawings?

No. We can begin reviewing your energy models without approved electrical permit documents, but you have to submit the approved electrical permit documents before we issue the permit to get credit for high-performance lighting.

Renewables

Table C407.5.1(1) states that "No on-site renewable energy shall be modeled in the Standard Reference Design, except that required by Section C411, without the exceptions." If Section C411 is not a mandatory section, then why is PV (photovoltaics) modeled in the SRD?

The Standard Reference Design always requires modeling of the PV described in Section C411. Your Proposed Design receives credit if it includes more PV than required by Section C411. There is no upper limit on the amount of renewables allowed for code compliance.

Additional efficiency options (C406 measures) Why are there now three different compliance savings thresholds (87%, 90%, and 93%) related to the inclusion or exclusion of additional efficiency options (C406)?

For prescriptive code compliance, you have to include two C406 options in your design. For Total Building Performance, you can choose to include the C406 options in your Proposed Design, or else to exclude one or both options from the Proposed Design and meet a more stringent energy efficiency target.

Do I have to include C406 measures in my proposed design to model them in my reference design and thus decrease the required savings?

Yes. The table below shows the allowable combinations and resulting impact on the savings threshold. Note that this example assumes it is the same measure in both cases.

C406 Modeling Options		
In Proposed Model	**In Reference Model**	**Savings Threshold (new Construction)**
0 C406 measures	0 C406 measures	87%
0 C406 measures	1 C406 measure	87%*
0 C406 measures	2 C406 measures	87%*
1 C406 measure	0 C406 measures	87%
1 C406 measure	1 C406 measure	90%
2 C406 measures	0 C406 measures	87%
2 C406 measures	1 C406 measure	90%
2 C406 measures	2 C406 measures	93%
* These rows clarify that you must include C406 measures in the proposed design in order to model C406 measures in the reference model and increase the savings threshold.		

When does it make sense to include C406 measures in the reference energy model?

If the C406 measure saves more than 3% of total building energy use, it will be most beneficial to the overall savings calculation to exclude it in the reference model. If the C406 measures saves less than 3% of total building energy use, it will be most beneficial to the overall savings calculation to include it in the reference model and reduce the savings threshold.

What documentation do I have to submit for C406 measures?

Indicate the selected options (including detailed requirements) on your permit documents and in the Total Building Performance report. We don't require additional documentation or proof of design to illustrate compliance with the C407 Total Building Performance Path or to be included in the energy model(s).

If C406 options are included in the project, how should the Standard Reference Design and Proposed Design energy models address them?

The following sections provide guidance and clarifications on how to approach each of the eight C406 measures within the context of a Total Building Performance or Target Performance energy model. This guidance is not comprehensive. Note that you always have the choice of whether to include the C406 measure in the reference model, so the reference model guidance only applies if you choose to model the measure in the reference model.

C406.2 More efficient HVAC equipment and fan performance

Proposed Design Model:

- To be eligible for this option, the proposed design must use equipment listed in Tables C403.2.3(1)-C403.2.3(9). Therefore, projects with electric resistance heat cannot use this C406 measure. Note that air-to-water heat pumps and heat recovery chillers automatically comply.
- Exclude energy recovery ventilators from efficiency calculations.
- Define HVAC capacity as the sum of all typically operating equipment (AHU + and terminals). Provide a rationale for any excluded equipment.
- Cooling capacity and heating capacity must separately meet the requirement for 90% of the equipment to be listed in the C403.2.3 tables.

Standard Reference Design Model:

- Model equipment that is 15% more efficient than code minimum equipment.

C406.3 Reduced lighting power

Proposed Design Model:

- To qualify for this credit, the building's overall lighting power density (LPD) must be at least 25 percent lower than the interior lighting power allowances in Table C405.4.2.
- Typically, model LPD per your proposed design. If the LPD is not yet known, model it at 75 percent of the interior lighting power allowances in Table C405.4.2.
- Note that this degree of lighting efficiency is very difficult to achieve.
- LPD savings cannot be claimed for core and shell spaces where the lighting is not installed as part of this building permit.
- If an energy savings credit is taken for proposed lighting power density reductions, then, per Section C407.2, you must have an issued electrical permit before the building permit can be finalized.

Standard Reference Design Model:

- If you are not taking the C406 lighting energy savings credit, model the overall LPD as in your proposed design.
- If you are taking the C406 lighting energy savings credit, model the LPD at 75 percent of the interior lighting power allowances in Table C405.4.2.

C406.4 Enhanced digital lighting controls

- If you intend to pursue this measure and show compliance with the six requirements in C406.4, do not model this measure in either model. Increase the savings threshold by 3%.
- Alternatively, justify higher savings via your own modeling methodology, if it is approved by the code official in a pre-submittal meeting.

C406.5 On-site renewable energy

Proposed Design Model:

- Provide 0.25 watts (or 0.85 Btuh) of renewable energy per square foot of conditioned floor area and show calculation for resulting annual energy production.
- Subtract calculated energy from total building energy use.
- Note that the required C406 capacity is not limited to the largest 5 floors; it is based on the entire building conditioned floor area.
- With C407 Total Building Performance Path compliance, you can obtain the C406 measure without

also installing the required energy efficiency requirements in Section C411. This is because C411 can be traded in energy modeling – it should be included in the SRD.

Standard Reference Design Model:

- Be sure to include renewable energy or the equivalent exception (Section C411) in the reference model.
- Provide 0.25 watts (or 0.85 Btuh) of renewable energy per square foot of conditioned floor area and your calculation for the resulting annual energy production.
- Subtract calculated energy from the total building energy use.
- Match the renewable energy type in the reference model to that used in your proposed model.

C406.6 Dedicated outdoor air system (DOAS)

Proposed Design Model:

- Model DOAS as designed for your project.

Standard Reference Design Model:

- Model DOAS if required per the reference system selection in Section C407. If it's not required, model the required alternate system.
- Regardless of whether DOAS is required or not, decrease the compliance margin by 3%. This is an intentional and allowable instance of "double dipping."

C406.7 Reduced energy use in service water heating

Proposed Design Model:

- This measure is only available if your building is one of the stated building types or if your project has a domestic hot water annual energy use that is 10 % or more of annual building energy use. You should verify the method for justifying the percentage of annual building energy use in a pre-submittal meeting.
- The minimum Coefficient of Performance (COP) requirement for the proposed design is a rated, not annualized, COP.

Standard Reference Design Model:

- The reference model shall use Option 1, heat pump, unless otherwise coordinated during a pre-submittal meeting.

C406.8 Enhanced envelope performance

Proposed Design Model:

- Model all proposed envelope assemblies as designed. Using the proposed envelope assembly types and areas, provide a calculation to confirm the total UA of the proposed building thermal envelope is at least 15% lower than the maximum allowable UA in accordance with C406.8.

Standard Reference Design Model:

- Reduce the U-factor or F-factor by 15% for each assembly type in the standard reference model.

C406.9 Reduced air leakage

Proposed Design Model:

- Model reduced air leakage value.
- If the constructed building does not meet the target value, SDCI will withhold the final certificate of occupancy until you implement measures that save an equivalent amount of energy.

Standard Reference Design Model:

- Model reduced air leakage value.

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- Qing Zhang, Rushing Co

Access to Information

Links to electronic versions of SDCI **Tips, codes**, and **forms** are available on the "Tools & Resources" page of our website at **www.seattle.gov/sdci**. Paper copies of these documents are available from our Public Resource Center, located on the 20th floor of Seattle Municipal Tower at 700 Fifth Ave. in downtown Seattle, (206) 684-8467.

Summary of Modifications to C407 Text in Director's Rule 9-2018

SPECIFICATIONS FOR THE STANDARD REFERENCE DESIGN HVAC SYSTEM DESCRIPTIONS

SYSTEM NO.	SYSTEM TYPE	FAN CONTROL	COOLING TYPE	HEATING TYPE (((~~Column A)~~[m]))	~~((HEATING TYPE))~~ (((~~Column B)~~[n]))
1	Variable air volume with parallel fan-powered boxes[a]	VAV[d]	Chilled water[e]	Electric resistance	((~~Hot water with electric heat pump~~[o]))
2	Variable air volume with reheat[b]	VAV[d]	Chilled watere	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
3	Packaged variable air volume with parallel fan-powered boxes[a]	VAV[d]	Direct expansionc	Electric resistance	((~~Hot water with electric heat pump~~[o]))
4	Packaged variable air volume with reheat[b]	VAVd	Direct expansion[c]	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
5k	Two-pipe fan coil	Constant volume[i, j, p]	Chilled water[e]	Electric resistance	((~~Hot water with electric heat pump~~[o]))
6k	Water-source heat pump	Constant volume[i, j, p]	Direct expansion[c]	Electric heat pump and boiler[g]	((~~Electric heat pump and boiler~~[g]))
7k	Four-pipe fan coil	Constant volume[i, j, p]	Chilled watere	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
8k	Packaged terminal heat pump	Constant volume[i, j, p]	Direct expansion[c]	Electric heat pump[h]	((~~Electric heat pump~~[h]))
9k	Packaged rooftop heat pump	Constant volume[i, j]	Direct expansion[c]	Electric heat pump[h]	((~~Electric heat~~
10[k]	Packaged terminal air conditioner	Constant volume[i, j, p]	Direct expansion	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
11[k]	Packaged rooftop air conditioner	Constant volume[i, j]	Direct expansion	Fossil fuel furnace	((~~Hot water with electric heat pump~~[o]))

Footnotes for Table C407.5.1(4)

i. Constant volume: For building types governed by Section C403.6, fans shall be controlled to cycle with load, i.e., fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall be modeled per C407.5.3. Effective October 1, 2018, residential dwelling or sleeping unit fans shall be controlled per footnote p of Table C407.5.1(4). For all other buildings and residential dwelling or sleeping units prior to October 1, 2018, fans shall be controlled in the same manner as in the proposed design, i.e., fan operation whenever the space is occupied, or fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy be modeled per C407.5.3.

j. Fan speed control: Effective October 1, 2018, residential dwelling and sleeping unit fan speed control shall operate per footnote p of Table C407.5.1(4). For all other building areas and residential dwelling or sleeping units prior to October 1, 2018, fans ((~~Fans~~)) shall operate as one- or two-speed as required by Section C403.2.11.5, regardless of the fan speed control used in the proposed building.

***

m. (Reserved)

n. (Reserved)

o. (Reserved)

p. Dwelling unit and sleeping unit Standard Reference Design: Effective October 1, 2018 the Standard Reference Design for dwelling units and sleeping units in R-1, R-2 and R-3 occupancies shall comply with one of the following:

1. Where the proposed HVAC system utilizes whole house ventilation with exhaust fan systems in accordance with SMC Section 403.4.6, or whole house ventilation integrated with forced-air systems in accordance with SMC Section 403.4.7, the reference model ventilation system will utilize whole house exhaust with a fan power allowance of 1.4 cfm/watt in accordance with Table C403.2.11.4. The reference model outdoor airflow rate will be modeled as continuous or intermittent ventilation, in accordance with SMC Section C403.4.5.1, as defined by the proposed design. The reference model ventilation system will operate in parallel with the heating and cooling system. The reference model heating and cooling systems will cycle to meet the heating and cooling load in the space. Heating and cooling system fan speed control will operate as one- or two-speed as required by Section C403.2.11.5, regardless of the fan speed control used in the proposed building and have a fan power allowance as defined by Table C407.5.1(1). The fan power, operating schedule, and airflow rates of bath, laundry, dryer, range, transfer and other miscellaneous exhaust fans will be identical between the reference and proposed energy models.

2. Where the proposed HVAC system includes whole house ventilation with supply fan systems in accordance with SMC Section 403.4.8, or whole house ventilation with heat recovery or energy recovery ventilation systems in accordance with SMC Section 403.4.9, the reference model will include a supply fan system without heating and/or cooling with a separate “all other systems, including DOAS” fan power allowance as defined by Table C407.5.1(1). The reference model will not include energy recovery or heat recovery per Exception 9 of C403.5. The reference model outdoor airflow rate will be modeled as continuous or intermittent ventilation, in accordance with SMC Section C403.4.5.1, as defined by the proposed design. The reference model ventilation system will operate in parallel with the heating and cooling system. The reference model heating and cooling systems will cycle to meet the heating and cooling load in the space. Heating and cooling system fan speed control will operate as one- or two-speed as required by Section C403.2.11.5, regardless of the fan speed control used in the proposed building and have a fan power allowance as defined by Table C407.5.1(1). The fan power, operating schedule and airflow rates of bath, laundry, dryer, range, transfer and other miscellaneous exhaust fans will be identical between the reference and proposed energy models.

TABLE C407.5.1(4)

SPECIFICATIONS FOR THE STANDARD REFERENCE DESIGN HVAC SYSTEM DESCRIPTIONS

SYSTEM NO.	SYSTEM TYPE	FAN CONTROL	COOLING TYPE	HEATING TYPE (((~~Column A~~)[m]))	~~((HEATING TYPE~~)) (((~~Column B~~)[n]))
1	Variable air volume with parallel fan-powered boxes[a]	VAV[d]	Chilled water[e]	Electric resistance	((~~Hot water with electric heat pump~~[o]))
2	Variable air volume with reheat[b]	VAV[d]	Chilled watere	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
3	Packaged variable air volume with parallel fan-powered boxes[a]	VAV[d]	Direct expansionc	Electric resistance	((~~Hot water with electric heat pump~~[o]))
4	Packaged variable air volume with reheat[b]	VAVd	Direct expansion[c]	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
5k	Two-pipe fan coil	Constant volume[i, j, p]	Chilled water[e]	Electric resistance	((~~Hot water with electric heat pump~~[o]))
6k	Water-source heat pump	Constant volume[i, j, p]	Direct expansion[c]	Electric heat pump and boiler[g]	((~~Electric heat pump and boiler~~[g]))
7k	Four-pipe fan coil	Constant volume[i, j, p]	Chilled watere	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
8k	Packaged terminal heat pump	Constant volume[i, j, p]	Direct expansion[c]	Electric heat pump[h]	((~~Electric heat pump~~[h]))
9k	Packaged rooftop heat pump	Constant volume[i, j]	Direct expansion[c]	Electric heat pump[h]	((~~Electric heat~~
10[k]	Packaged terminal air conditioner	Constant volume[i, j, p]	Direct expansion	Hot water fossil fuel boiler[f]	((~~Hot water with electric heat pump~~[o]))
11[k]	Packaged rooftop air conditioner	Constant volume[i, j]	Direct expansion	Fossil fuel furnace	((~~Hot water with electric heat pump~~[o]))

Footnotes for Table C407.5.1(4)

i. Constant volume: For building types governed by Section C403.6, fans shall be controlled to cycle with load, i.e., fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall be modeled per C407.5.3. Effective October 1, 2018, residential dwelling or sleeping unit fans shall be controlled per footnote p of Table C407.5.1(4). For all other buildings and residential dwelling or sleeping units prior to October 1, 2018, fans shall be controlled in the same manner as in the proposed design, i.e., fan operation whenever the space is occupied, or fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy be modeled per C407.5.3.