ADDENDA

ANSI/ASHRAE/IES Addendum ag to
ANSI/ASHRAE/IES Standard 90.1-2019

Energy Standard for Buildings Except Low-Rise Residential Buildings

Approved by the ASHRAE Standards Committee on July 20, 2022; by the ASHRAE Board of Directors on August 15, 2022; by the Illuminating Engineering Society on September 8, 2022; and by the American National Standards Institute on September 9, 2022.

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 ISSN 1041-2336

Approved American National Standard

www.ansi.org

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FOREWORD

Addendum ag adds an optional Mechanical System Performance Path. Currently this path is restricted to HVAC system efficiency tradeoffs in Section 6 only but is anticipated to expanded in the future to include service water heating systems in Section 7 to allow heat recovery efficiency and other service water heating improvements to be credited.

Structurally, the proposal includes three parts:

- *Restructure and modify Section 6.2 to add total system performance ratio (TSPR) as an alternate HVAC performance path.*
- *Add new Section 6.6.2, "Mechanical System Performance Path," which includes requirements for compliance with the new alternate performance path.*
- *Add new Normative Appendix J, which includes detailed information on what systems are allowed or excluded as well as how to calculate TSPR. Appendix J is organized into three parts:*
  - *Sections J1 and J2 include requirements to meet TSPR and proposed building information needed from the designer.*
  - *Sections J3 and J4 include simulation program requirements and reference system specifications primarily for software developers.*
  - *Section J5 provides informative alternate metrics for local jurisdiction adoption.*

Why TSPR?

While easy to use and understand, the prescriptive path limits design flexibility and fails to acknowledge individual building characteristics or system improvements that can optimize a building's energy performance with integrated solutions. Because prescriptive requirements are typically established at an individual component level and limited by cost-effectiveness requirements, the rate of improvement of each subsequent code has slowed based on economic considerations and limits of technological feasibility. In addition, such component efficiency ratings are based on standard rating conditions that may not reflect actual building conditions and the climate of the building site. The HVAC system performance approach accounts for all of these system parameters to provide a comprehensive evaluation of a building's HVAC system.

Improvements in prescriptive requirements may limit design flexibility. To continue progress, code developers have increasingly focused on performance paths to help maintain the design flexibility desired by the architectural and engineering community.

In some cases, prescriptive requirements call for systems that may not be practical or effective in all building situations. For example:

- *Outdoor air economizers may not be practical for some system types in some buildings, yet they are required unless excepted.*
- *In some buildings, the absolute fan power limits in the prescriptive path may be challenging to achieve.*

Currently, to make a trade-off for any prescriptive requirements, a full building analysis is required under Section 11 or Appendix G of Standard 90.1. This can require substantial time for professional analysis. A mechanical performance method would allow a simplified building input and adequately assess mechanical system efficiency tradeoffs. The Mechanical System Performance Path is much simpler than standard whole-building performance energy modeling, providing a solution more informative than a prescriptive-based approach without the complexities and costs of a whole-building performance-based approach. In addition, specific systems that tend to have lower efficiencies are located in a list of excluded systems in Section J1.1.1.2 to make clear that these systems could follow the prescriptive path, while the remainder of the building could use TSPR.

TSPR Defined

The Mechanical System Performance Path is designed to provide tradeoffs within the mechanical system while maintaining equivalent energy efficiency with the prescriptive path. The system performance approach uses a new metric—total system performance ratio—for evaluating an HVAC system. TSPR analyzes all *components of the HVAC system, accounts for part-load performance and system controls, and normalizes for building loads. The TSPR metric addresses multiple issues, as it measures the amount of energy required to deliver each unit of heating and cooling to the building over the course of a typical year. TSPR is larger when a system is more efficient and is represented as follows:*

$$TSPR = \frac{Delivered\ HVAC\ Loads}{HVAC\ Input}$$

where

Delivered HVAC Loads	=	*sum of the annual heating and cooling loads met by the building HVAC system, thousand Btu (kWh).*
HVAC Input	=	*sum of the annual HVAC energy input for heating, cooling, fans, energy recovery, pumps, and heat rejection. The HVAC energy input units are generally annual HVAC system energy cost, although jurisdictions may substitute metrics like carbon emissions, source energy, or site energy.*

A larger TSPR indicates a lower heating and cooling energy cost to meet the same HVAC annual loads and, therefore, indicates a more efficient HVAC system. The annual heating and cooling loads are based on proposed building envelope loads; internal loads due to lights, equipment, and occupants; and ventilation and infiltration loads. This metric provides a single evaluation criterion that addresses all components of the HVAC systems used to move heat and air into, out of, and within a building. It includes distribution system effectiveness, considers both full- and part-load performance, and accounts for system controls. Provision is made to allow software to use either part-load curves or other part-load adjustment methods for both proposed systems and reference systems. It differs from standard system efficiency ratings (such as seasonal energy efficiency ratio, coefficient of performance, or kilowatt hours per ton) that usually address part of a system and fail to account for all the system inefficiencies that may be present within a building as well as their interaction with building loads and ventilation requirements.

Systems using the same or less overall annual energy as a selected target system to meet the building's annual thermal and ventilation loads would be rated as equivalent or more efficient. This addendum defines a TSPR requirement by comparing a proposed mechanical system ($TSPR_p$) with a reference mechanical system ($TSPR_r$). The reference system is generally aligned with Normative Appendix G requirements that are roughly equivalent to Standard 90.1-2004. The improvement for the proposed system would then need to be greater than or equal to the improvement for a target system ($TSPR_t$). Efficiency equivalence is demonstrated where

$$(TSPR_p \geq TSPR_t)\ OR\ \left(\frac{TSPR_p}{TSPR_r} \geq \frac{TSPR_t}{TSPR_r}\right)$$

This is simplified by using a mechanical performance factor (MPF) that represents the improvement in system output per cost for a target system ($TSPR_t$) compared to the reference system $TSPR_r$. A technical document and supporting EnergyPlus input files outlining the target systems and supporting the MPF development is available at www.energycodes.gov/sites/default/files/2021-10/TechDoc_901-TSPR_2021oct21.pdf). This allows the reference systems to remain stable in software, with only a table of MPFs updated for each edition of Standard 90.1. The MPFs are unique to building type and climate zone. The target systems are selected to represent a typical prescriptive system based on consensus discussion of the SSPC 90.1 Mechanical Subcommittee.

$$TSPR_p > TSPR_r/MPF$$

where

$TSPR_p$	=	*proposed TSPR*
$TSPR_r$	=	*reference TSPR*
MPF	=	*mechanical performance factor based on climate zone and building use type (MPF = $TSPR_r$/ $TSPR_t$)*

The Mechanical System Performance Path is implemented with the brief addition of an alternative path in Section 6 and then supported by new Normative Appendix J, which provides direction to the user and simulation program developer to meet the TSPR calculation requirements. The U.S. Department of Energy has committed to support Pacific Northwest National Laboratory in developing one version of software that meets the requirements of Normative Appendix J. Other developers can create their own versions of the software or incorporate the TSPR calculation into existing HVAC system design software. Not every implemen-

tation of TSPR software needs to cover every system, just all TSPR systems included in the specific building being evaluated.

Cost Considerations

This addendum creates an optional performance path in the standard designed to provide increased flexibility. Because the path is optional, it does not create a code requirement for increased costs and therefore is not subject to cost-effectiveness analysis.

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 ag to Standard 90.1-2019

Modify Section 3.2 as shown (I-P and SI).

[. . .]

total system performance ratio (TSPR): ratio of the sum of a *building's* annual heating and cooling load in thousand Btu (kWh) to the sum of annual *energy* input of the *building* mechanical *systems,* where the input units are in accordance with Section J5.

[. . .]

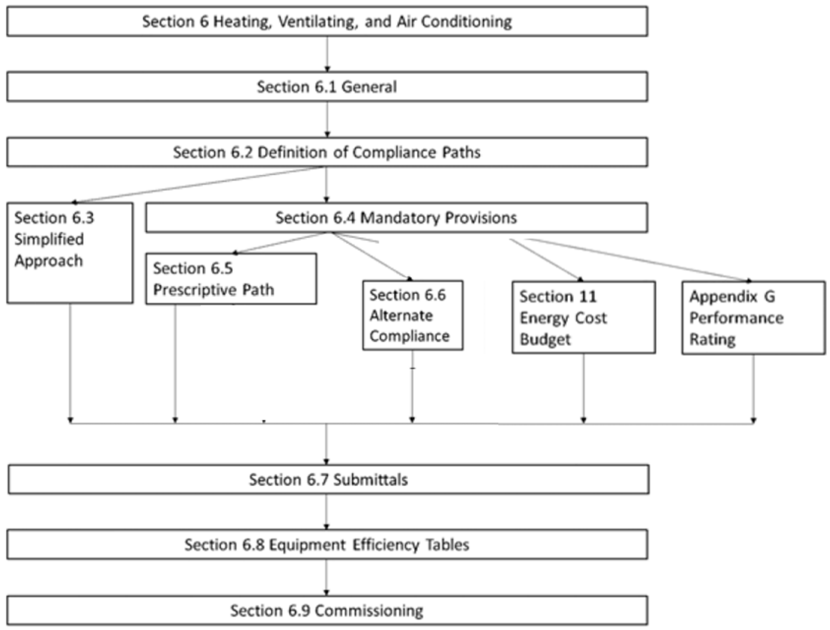
TSPR reference building design: a computer representation of a hypothetical *building* design based on modifications to the *proposed design* in accordance with Section J4.3. This representation is used as the basis for calculating the mechanical *total system performance ratio* for determining alternative mechanical *system* performance in accordance with Section 6.6.2.

Modify Section 3.3 as shown (I-P and SI).

DOAS	dedicated *outdoor air system*
FPTU	fan-powered *terminal* unit
CHW	chilled water
CHWST	chilled-water supply temperature
HWST	heating-water supply temperature
MPF	mechanical performance factor
OAT	*outdoor air* temperature (dry-bulb unless wet-bulb is specified)
OA	*outdoor air*
RAT	return air temperature (dry-bulb unless wet-bulb is specified)
SAT	supply air temperature (dry-bulb unless wet-bulb is specified)
TSPR	total system performance ratio
$TSPR_p$	*TSPR* of a *proposed design*
$TSPR_r$	*TSPR* of a *TSPR reference building design*
VSD	variable-speed drive

[. . .]

Replace the Section 6 flow chart with the image shown (I-P and SI).



Modify Section 6 as shown (I-P and SI).

6.2 Compliance Paths. Mechanical ~~equipment~~ *equipment* and ~~systems~~ *systems* providing heating, cooling, ventilating, or refrigeration shall comply with Section 6.2.1 and Section 6.2.2.

6.2.1 Requirements for All Compliance Paths. Mechanical ~~equipment~~ *equipment* and ~~systems~~ *systems* shall comply with all of the following:

a. Section 6.1, "General"~~;~~
b. Section 6.4, "Mandatory Provisions"~~;~~
   Exception to 6.2.1(b): When compliance is shown using Section 6.2.2(a), compliance with Section 6.4 is not required unless required in Section 6.3.2.
c. Section 6.7, "Submittals"~~; and~~
d. Section 6.8, "Minimum *Equipment Efficiency* Tables~~.~~"

6.2.2 Additional Requirements to Comply with Section 6. Refrigeration *equipment* and *systems* shall comply with Section 6.5, "Prescriptive Compliance Path." ~~Mechanical equipment and systems~~ All *building HVAC systems* shall comply with one of the following:

a. Section 6.3, "Simplified Approach *Building* Compliance Path for *HVAC Systems*"
   ~~**Exception to 6.2.2(a):** When compliance is shown using Section 6.2.2(a), compliance with Section 6.4 is not required.~~
b. Section 6.5, "Prescriptive Compliance Path"
   ~~**Exception to 6.2.2(b):** *HVAC systems* only serving the heating, cooling, or ventilating needs of a *computer room* with IT *equipment* load greater than 10 kW shall be permitted to comply with Section 6.4, "Mandatory Provisions" and Section 6.6, "Alternative Compliance Path."~~
c. Section 6.6.1, "*Computer Room System* Path"
d. Section 6.6.2, "Mechanical *System* Performance Path"

Informative Note: Section 6.3 requires all *HVAC systems* in the *building* to qualify for the simplified path. Section 6.6.2 requires all allowable *systems* to meet Normative Appendix J requirements. Section 6.6.2 does allow part of the *building* to use the Mechanical *System* Performance Path and part of the *building* to use Section 6.5 where there are excluded occupancy types or *system* types in Section J1.1.1.2. *HVAC systems* for larger *computer rooms* may comply with either Section 6.5, 6.6.1, or 6.6.2.

[. . .]

6.6 Alternative Compliance Paths

6.6.1 Computer Rooms Systems~~s~~ Path. The *Computer Room System* Path is an optional path for compliance where the following conditions are met:

Table 6.6.2.2 Mechanical Performance Factors (MPF)

	Climate Zone																		
***Building* type**	**0A**	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Office (small and medium)[a]	0.72	0.71	0.70	0.70	0.68	0.65	0.71	0.66	0.62	0.69	0.64	0.65	0.72	0.66	0.65	0.74	0.70	0.75	0.77
Office (large)[a]	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.84	0.78	0.69	0.80	0.67	0.72	0.75	0.67	0.73	0.73	0.71	0.70
Retail	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.46	0.38	0.40	0.45	0.48	0.41	0.50	0.47	0.44	0.39	0.40	0.36
Hotel/motel	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.59	0.66	0.65	0.55	0.59	0.68	0.51	0.54	0.47	0.40
Multifamily/ dormitory	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.68	0.54	0.59	0.57	0.52	0.58	0.53	0.48	0.57	0.53	0.55	0.52
School/education	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.68	0.67	0.71	0.65	0.72	0.68	0.60	0.75	0.69	0.72	0.68

a. Office sizes defined in Section J1.1.1.1.

a. *HVAC systems* that only serve~~ing~~ the heating, cooling, or ventilating needs of a *computer room* with IT *equipment* load greater than 10 *kW* shall comply with ASHRAE Standard 90.4, *Energy Standard for Data Centers*.
b. All other *HVAC systems* shall comply with the applicable requirements in Section 6.5.

6.6.2 Mechanical System Performance Path

6.6.2.1 Scope. The Mechanical *System* Performance Path is an optional path for compliance where the following conditions are met:

a. All *HVAC systems* in the *building* that meet the criteria in Section J1.1.1 shall comply with Section 6.6.2.2.
b. All other *HVAC systems* shall comply with one of the following:
   1. *HVAC systems* shall comply with the applicable requirements in Section 6.5.
   2. *HVAC systems* that only serve the heating, cooling, or ventilating needs of a *computer room* with IT *equipment* load greater than 10 *kW* shall be permitted to comply with ANSI/ASHRAE Standard 90.4, *Energy Standard for Data Centers*.

6.6.2.2 Criteria. *HVAC systems* in new *buildings, additions,* or *alterations* shall comply with the requirements in Section J2, "Mechanical *System* Performance Rating Method." The *proposed design total system performance ratio* (*$TSPR_p$*) of the *HVAC systems* using this method shall be greater than or equal to the *total system performance ratio* of the *TSPR reference building design* (*$TSPR_r$*) divided by the mechanical performance factor (MPF) when calculated in accordance with the following:

$$TSPR_p > TSPR_r/\mathrm{MPF}$$

where

$TSPR_p$ = proposed *TSPR* calculated in accordance with Normative Appendix J

$TSPR_r$ = reference *TSPR* calculated in accordance with Normative Appendix J

MPF = mechanical performance factor from Table 6.6.2.2 based on climate zone and *building* use type

Where a *building* has multiple *building* use types, MPF shall be area weighted as follows:

$$\mathrm{MPF} = (A_1 \times \mathrm{MPF}_1 + A_2 \times \mathrm{MPF}_2 + \ldots + A_n \times \mathrm{MPF}_n)/(A_1 + A_2 + \ldots + A_n)$$

where

$\mathrm{MPF}_1, \mathrm{MPF}_2, \ldots, \mathrm{MPF}_n$ = mechanical performance factors from Table 6.6.2.2 based on climate zone and *building* use types 1 through *n*

$A_1, A_2, \ldots, A_n$ = conditioned *floor* areas for *building* use types 1 through *n*

Informative Note: The Mechanical *System* Performance Rating Method is a simplified performance trade-off approach for *HVAC systems* that does not require using the whole-*building* trade-off approaches in Section 11 or Normative Appendix G. *HVAC systems* that are allowed to use this approach will not need to comply with all of the prescriptive requirements in Section 6.5. For example, an *HVAC system* without a required *outdoor air economizer* can show compliance with Section 6 by demonstrating improved cooling *efficiency* or reduced fan *energy* use compared to a reference *HVAC system* that meets all prescriptive requirements, including outdoor air *economizers*. This approach does not allow *HVAC system efficiency* trade-offs with *building envelope*, plug loads, or lighting *systems*.

[. . .]

Add new Normative Appendix J as shown (I-P and SI).

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX J
MECHANICAL SYSTEM PERFORMANCE RATING METHOD

J1. GENERAL

J1.1 Scope. This appendix offers an alternative path of compliance for *HVAC systems* in accordance with Section 6.6.2. This appendix establishes the requirements for *HVAC systems* that use the Mechanical *System* Performance Rating Method and requirements for calculating $TSPR_p$ and $TSPR_r$ to demonstrate compliance in accordance with Section 6.6.2.2. Not all *HVAC systems* are allowed to use the Mechanical *System* Performance Rating Method as described in J1.1.1.

J1.1.1 Allowable HVAC Systems. *HVAC systems* are allowed to use the Mechanical *System* Performance Rating Method if they comply with all the following criteria:

a. The *HVAC system* type is included in Table J1.1.1.
b. The *HVAC system* serves a *building* use type included in Section J1.1.1.1.
c. The *HVAC system* is not excluded by Section J1.1.1.2.
d. The *HVAC system* is powered by grid-delivered electricity, renewable electricity, natural gas, propane, renewable thermal *energy*, or distillate fuel oil.

Informative Notes:

1. The intention of the scope is to allow most of the *building* to use the *TSPR* path and have portions of the *buildings* that cannot use the *TSPR* path use either the prescriptive path or the *Computer Room System* Path.
2. The allowed *system* types may not be supported by all simulation program versions. The simulation program is required to support the reference *systems* for the *building* types modeled, and the proposed *system* type(s) must be supported by the *simulation program*.

J1.1.1.1 Allowable Building Use Types. *HVAC systems* that serve the following *building* use types are allowed to use the Mechanical *System* Performance Rating Method:

a. Large office (*gross conditioned floor area* >150,000 ft^2 [14,000 m^2] or >5 floors)
b. Medium office (*gross conditioned floor area* 5000 to 150,000 ft^2 [460 to 14,000 m^2] and ≤5 floors)
c. Small office (*gross conditioned floor area* ≤5000 ft^2 (460 m^2) and ≤5 floors)
d. Retail
e. Multifamily (including dormitory)
f. Hotel (including motel)
g. School (including education and university)
h. Other *building* use types that are <1000 ft^2 (93 m^2) and <10% of the *building* conditioned floor area unless specifically excluded by Section J1.1.1.2(a)

Informative Note: Item (h) allows for a small sandwich or coffee counter service area but not a restaurant in an office *building* lobby or bookstore, for example.

J1.1.1.2 Excluded HVAC Systems. The following *HVAC systems* are excluded from using the Mechanical *System* Performance Rating Method:

a. *HVAC systems* serving one of the following excluded *building* areas:
   1. Data centers and *computer rooms* with *equipment* power density exceeding 20 W/ft^2 (216 W/m^2) of conditioned floor area and exceeding 10 *kW* of *equipment* load
   2. Laboratories with fume hoods
   3. Locker rooms with more than four (4) showers
   4. Cafeterias and dining rooms

Table J.1.1.1 Proposed Building HVAC Systems Allowed to Use the Mechanical System Performance Rating Method

System No.	*System* Name
1	*Packaged terminal air conditioner* (with electric or hydronic heat)
2	Packaged terminal heat pump
3	Packaged single-zone furnace[a] and/or air-cooled air conditioner (includes split systems[b])
4	Packaged single-zone heat *pump* (air-to-air only) (includes split systems[b] and electric or gas supplemental heat)
5	*VRF system* (air source)
6	Four-pipe fan coil
7	Water-source heat *pump* (water loop), water-source *VRF system*, or water-source air conditioner
8	Ground-source heat *pump*
9	Packaged *VAV system* (DX cooling)[a]
10	*VAV system* (hydronic cooling)[a]
11	*VAV system* with fan-powered terminal units
12	DOAS (in conjunction with *systems* 1 through 8)

a. Reheat or primary heat may be electric, hydronic, or gas furnace.
b. Condensing units with DX air handlers are modeled as package furnace with air conditioners or heat *pumps*.
Informative Note: See Section 3.3 for a full list of terms used in this table.

5. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h (30 *kW*) (does not include break rooms)
6. Natatoriums or rooms with saunas
7. Areas of *buildings* with commercial refrigeration *equipment* exceeding 100 *kW* of power input

b. *HVAC systems* that are not replaced in their entirety as part of an *alteration* and are not serving initial build-out construction

c. *HVAC systems* serving *portions* of the *building* that are also served in parallel by other *HVAC systems* not allowed to use the Mechanical *System* Performance Rating Method

d. *HVAC systems* using any of the following:
1. District heating or cooling
2. Small-duct high-velocity air-cooled, space-constrained air-cooled, single-package vertical air conditioner, single-package vertical heat *pump*
3. Double-duct air conditioner or double-duct heat *pump* as defined in subpart F to 10CFR part 431
4. *Packaged terminal air conditioners* and *packaged terminal heat pumps* that have cooling capacity greater than 12,000 Btu/h (3500 *kW*)
5. Systems with a common heating source serving both HVAC and *service water heating equipment*
6. *HVAC systems* that provide recovered heat for *service water heating*

Exceptions to J1.1.1.2(a) and (c):
1. Multiple-zone *HVAC systems* in Table J1.1.1, including dedicated *outdoor air systems*, where 80% or more of *system* supply air serves allowed *building* use types in accordance with Section J1.1.1.1 and 20% or less of *system* supply air serves excluded areas in items (a) or (c).
2. Central chiller or *boiler* plants where 80% or more of capacity serves allowed *building* use types in accordance with Section J1.1.1.1 and 20% or less of capacity serves excluded areas in items (a) or (c).

J2. MECHANICAL SYSTEM PERFORMANCE RATING METHOD

J2.1 Compliance

J2.1.1 Mandatory Requirements. All *HVAC systems* in the proposed *building* design shall comply with the requirements in Section 6.2.1.

Informative Note: *Buildings* using the Mechanical *System* Performance Rating Method are required to meet all mandatory provisions in Section 6.4 in accordance with Section 6.2.1. For example, while *demand control ventilation* (*DCV*) controlled area in the proposed *building* is one of the user entries in the simulation program, the minimum entry needs to meet the floor area where *DCV* is required in accordance with Section 6.4.3.8. The intent of this entry is to give credit for *DCV* control in more area than required, but not to allow *DCV* that is a mandatory requirement to be traded off with other *efficiency* improvements.

J2.1.2 Mechanical System Performance Rating Method Requirements. All *HVAC systems* using the Mechanical *System* Performance Rating Method shall demonstrate compliance using $TSPR_p$ and $TSPR_r$ in accordance with Section 6.6.2 and the following requirements:

a. $TSPR_p$ and $TSPR_r$ shall be calculated in accordance with Section J2.1.5, "Calculating *TSPR*," and the requirements of Sections J2, J3, J4, and J5.
b. *Alterations* that include replacement of the entire *HVAC system* shall be modeled as a new *building*.
c. *HVAC systems* shall comply with Section J2.1.4 "Partial Prescriptive Requirements."
d. Initial build-out construction shall be modeled in accordance with Section J2.1.3, "Core and Shell/Initial Build-Out Construction Analysis."
e. Compliance documentation and supplemental information shall be submitted in accordance with Sections 4.2.2 and J2.1.6 "*TSPR* Submittals."

J2.1.3 Core and Shell/Initial Build-Out 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:

a. Where the *HVAC zones* that do not include *HVAC systems* in the current permit will be or are served by independent *systems*, the block (See Section J2.2.1) including those zones shall not be included in the model.
b. Where the *HVAC zones* that do not include complete *HVAC systems* in the permit are intended to receive HVAC services from *systems* in the permit, their proposed zonal *systems* shall be modeled with *equipment* that meets but does not exceed the requirements of Sections 6.4 and 6.5.
c. Where the zone *equipment* in the permit receives HVAC services from previously installed *systems* that are not in the permit, the previously installed *systems* shall be modeled with *equipment* matching the certified value of what is installed or *equipment* that meets the requirements of Section 6.4 and Section 6.5, whichever has the more efficient *energy* use.
d. Where the central plant heating and cooling *equipment* is completely replaced and *HVAC zones* with *existing systems* receive HVAC services from *systems* in the permit, their proposed zonal *systems* shall be modeled with *equipment* that meets but does not exceed the requirements of Sections 6.4 and 6.5.

Informative Notes:

1. Examples of *HVAC systems* that are intended to receive HVAC services from *systems* in the permit include future zonal water source heat *pumps* that will receive loop water that is heated by a *boiler* or is cooled by a cooling tower included in the permit, any *system* that will receive outdoor *ventilation* air from a DOAS included in the permit, and future zone terminal units that will be connected to a central *VAV system* included in the permit.
2. An initial build-out with heating coils served from a previously installed *system* with a high-*efficiency* condensing *boiler* would use the installed *efficiency* if it exceeded the current requirements. If the installed *boiler* had a lower *efficiency* than the current requirements, the current requirement would be used.
3. A partial central plant upgrade (e.g., chiller but not *boiler* replacement) cannot use this method.

J2.1.4 Partial Prescriptive Requirements. *HVAC systems* using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section 6.5 as follows:

a. *Air economizers* shall meet the requirements of Sections 6.5.1.1.5 and 6.5.1.1.6.
b. Steam humidifiers shall meet requirements of Section 6.5.2.4.
c. *Variable-air-volume systems* shall meet requirements of Sections 6.5.3.2.2, 6.5.3.2.3, and 6.5.3.3.
d. Hydronic *systems* shall meet the requirements of 6.5.4.2.
e. Plants with multiple chillers or *boiler*s shall meet the requirements of Section 6.5.4.3.
f. Chilled-water and heating-water supply temperature reset shall meet the requirements of Section 6.5.4.4 without exception.
g. Hydronic (water loop) heat *pumps* and water-cooled *unitary air conditioners* shall meet the requirements of Section 6.5.4.5.
h. Cooling-tower turndown shall meet the requirements of Section 6.5.5.4.
i. Heating of unenclosed *spaces* shall meet the requirements of Section 6.5.8.1.

j. Hot-gas bypass shall meet the requirements of Section 6.5.9.
k. *Systems* shall meet the door switch *control* requirements of Section 6.5.10.
l. Refrigeration *systems* shall meet the requirements of Section 6.5.11.

J2.1.5 Calculating TSPR. $TSPR_p$ shall be calculated according to Equation J-1:

$$TSPR_p = \frac{\text{Loads}_r}{\text{HVACinput}_p} \tag{J-1}$$

where

Loads$_r$ = sum of the annual heating and cooling loads for the *TSPR reference building design* met by the *building HVAC system*, thousand Btu (kWh).

HVACinput$_p$ = sum of the annual HVAC *energy* input for heating, cooling, fans, *energy* recovery, *pumps*, and heat rejection for the *proposed design*. The HVAC *energy* input units shall be in accordance with Section J5.

$TSPR_r$ shall be calculated according to Equation J-2:

$$TSPR_r = \frac{\text{Loads}_r}{\text{HVACinput}_r} \tag{J-2}$$

where

Loads$_r$ = sum of the annual heating and cooling loads for the *TSPR reference building design* met by the *building HVAC system,* thousand Btu (kWh).

HVACinput$_r$ = sum of the annual HVAC *energy* input for heating, cooling, fans, *energy* recovery, *pumps*, and heat rejection for the *TSPR reference building design.* The HVAC *energy* input units shall be in accordance with Section J5.

Informative Note: The annual HVAC *energy* uses calculated using the Mechanical *System* Performance Rating Method are not predictions of whole-*building energy* consumption for an actual proposed *building* after construction. Actual experience will differ from these calculations due to variations such as occupancy, *building* operation and maintenance, weather, *energy* use of *systems* and *building* areas not covered by this procedure, changes in *energy* prices between design of the *building* and occupancy, and the precision of the calculation tool.

J2.1.6 TSPR Submittals. Where $TSPR_p$ and $TSPR_r$ are used to demonstrate compliance in accordance with Section 6.6.2, documentation shall be provided to the *building official* including the following:

a. A compliance report, as outlined in Section J3.4, generated by the *simulation program.*
b. A mapping of the actual *building* HVAC component characteristics and those simulated in the *proposed design* showing how individual pieces of HVAC *equipment* identified above have been combined into average inputs as required by the *simulation program*, including (but not limited to) the following:
   1. Fans
   2. Hydronic *pumps*
   3. Air handlers
   4. Packaged cooling *equipment*
   5. Furnaces
   6. Heat *pumps*
   7. *Boiler*s
   8. Chillers
   9. Heat-rejection equipment (open- and closed-circuit cooling towers; dry coolers)
   10. *Electric resistance* coils
   11. Condensing units
   12. Motors for fans and *pumps*
   13. *Energy* recovery devices
c. For each piece of *equipment* identified in item (b), include the following along with the units specified in Table J2.2.3 as applicable:
   1. *Equipment* name or tag consistent with that found on the design documents
   2. Rated *Efficiency* level, full-load *efficiency* as rated in Section 6.8

3. Rated capacity
4. Where not provided by the *simulation program* report in item (a), documentation of the calculation of any weighted equipment *efficiencies* input into the program.
5. Electrical input power for fans and *pumps* (before any speed or frequency *control device*) at design condition and calculation of input value (W/cfm [W·s/L] or W/gpm [W·s/L])

d. A floor plan of the *building* identifying how portions of the *building* are assigned to the simulated blocks (See Section J2.2.1) and which areas of the *building* are served by *HVAC systems* required to meet the requirements of Section 6.5 or Section 6.6.1.

Informative Note: The items listed under items (b) and (c) may either be included in the report generated by the *simulation program* or submitted separately. The compliance report required by Section J3.4 includes the composite *systems* entered into the program for the blocks. These may differ from actual *systems* and may be based on capacity *efficiency* weighting per Section J2.2.3.1. The *simulation program* may allow input of individual actual *systems* and perform the weighting, or it may require the user to perform that weighting separately and input the weighted *efficiencies*. In the second case, the weighted *efficiency* calculation would be included under item (c) here.

J2.2 Proposed Building Information Required. The simulation of *HVAC systems* and the *HVAC zones* they serve shall be modeled based on *building* information required by this section.

J2.2.1 Simplified Block Approach. The geometry of *buildings* shall be configured using one or more simplified geometric simulation *building* blocks, referred to as “blocks” in this appendix. Each block contains one or multiple *thermal blocks*. 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 block geometry and *HVAC system* assignment to blocks are met with appropriate assignment to thermal *zones*.

J2.2.1.1 Block Geometry. Each block shall define attributes including block dimensions, number of *floors*, floor-to-floor height, and floor-to-ceiling height. The *simulation program* is permitted to allow the use of simplified shapes (such as rectangle, L-shape, H-shape, U-shape, or T-shape) to represent blocks. Where actual *building* shape does not match these predefined shapes, simplifications are permitted providing the following requirements are met:

a. The *conditioned floor area* and volume of each block shall match the actual *proposed design* within 10%.
b. The area of each *exterior building envelope* component from Tables 5.5-1 through 5.5-8 is accounted for within 10% of the actual *proposed design*.
c. The area of vertical *fenestration* and *skylights* is accounted for within 10% of the actual *proposed design*.
d. The *orientation* of each component in items (b) and (c) is accounted for within 45 degrees of the actual *proposed design*.

The user shall create multiple blocks, if necessary, to meet these requirements.

J2.2.1.2 Number of Blocks. One or more blocks shall be created per *building* based on the following restrictions:

a. Each block shall have only one *building* use type. At least one single block shall be created for each unique use type, including where one *HVAC system* serves two different use types.
b. Each block shall be served by only one type of primary or zonal *HVAC system*. A dedicated *outdoor air system* (DOAS) *system* shall be permitted to serve blocks served by other *systems*. A single block shall be created for each unique primary or zonal *HVAC system* type and *building* use type combination. Multiple HVAC units of the same type are permitted to be represented in one block in accordance with Section J2.2.3.1.
c. Each block shall have a single definition of floor-to-floor or floor-to-ceiling heights. Where *floor* heights differ by more than 2 ft (6 m), unique blocks shall be created for the floors with varying heights.
d. Each block can include either above-*grade* or below-*grade* exterior *floors*. For *buildings* with both above-*grade* and below-*grade floors*, separate blocks shall be created for each. For *buildings* with *floors* partially above *grade* and partially below *grade*, if the total *wall* area of the floor(s) in consideration is greater than or equal to 50% above *grade*, it shall be simulated as a completely above-*grade* block; otherwise, it shall be simulated as a below-*grade* block.
e. In order to combine multiple *floors* into a single block, each *wall* on a façade of a block shall have similar *vertical fenestration area*. The product of the *proposed design U-factor* times the area of vertical *fenestration* (UA_{VerFen}) on each façade of a given floor cannot differ by more than 15% of the average UA_{VerFen} for that façade in each block. The product of the *proposed design solar heat gain coefficient*

(*SHGC*) times the area of vertical *fenestration* ($SHGCA_{VerFen}$) on each façade of a given floor cannot differ by more than 15% of the average $SHGCA_{VerFen}$ for that façade in each block. If these conditions are not met, additional blocks shall be created consisting of *floors* with similar *fenestration*.

f. For a *building* model with multiple blocks, each block façade input shall provide adequate information to identify the outside boundary condition (outside, inside to adjacent block, ground contact, or adiabatic) of each façade or portion of each façade that match the actual *proposed design*.

Informative Note: The *simulation program* may automatically identify the adjacent block façade outside boundary conditions through a graphic input process.

J2.2.2 Building Envelope Components. *Building envelope* thermal properties used in the *proposed design* shall be based on the actual *proposed design* using documented user-defined values and shall comply with all of the following:

a. Where different *roof* thermal properties are present in a single block, an area-weighted *U-factor* shall be used.
b. Where different *wall* constructions exist on the façade of a block, an area-weighted *U-factor* shall be used.
c. Where different *below-grade wall* constructions exist in a block, an area-weighted *C- factor* shall be used.
d. Where different *floor* constructions exist in the block, an area-weighted *U-factor* shall be used.
e. Where different *slab-on-grade floor* constructions exist in a block, an area-weighted *F-factor* shall be used.
f. Where different vertical *fenestration* types or sill heights exist, area-weighted sill heights, *U-factor*, and *SHGC* values shall be used.
g. Where different *skylight* types exist, area-weighted *U-factor* and *SHGC* values shall be used.
h. Permanent shading devices such as overhangs shall be modeled only if >50% of the area of vertical *fenestration* on a façade is shaded by the same.

J2.2.3 HVAC System Components. The *HVAC system* parameters shall be provided for the *proposed design* at *design conditions* unless otherwise stated with clarifications and simplifications as described in Table J2.2.3 and as follows:

a. All *HVAC zones* within a block shall be served by the same *HVAC system* type as listed in Table J1.1.1.
b. Where multiple *system* components serve a block, average values weighted by the appropriate metric as described in Section J2.2.3.1 shall be used.
c. The Table J2.2.3 parameter requirements 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 parameters to vary.

Informative Note: Table J2.2.3 includes both user-defined parameters and parameters that are fixed in the *simulation program* and may not be changed by the user. They are maintained in one table here so related items can be viewed together in context.

J2.2.3.1 Proposed Building HVAC System Aggregation. Projects using the Mechanical *System* Performance Rating Method shall comply with all the following requirements.

a. Where multiple fan *systems* serve a single block, fan power shall be based on weighted average using the design supply air (cfm [L/s]).
b. Where multiple cooling *systems* serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multistage if more than 50% of coil capacity serving the block is multistage with staged controls.
c. Where multiple heating *systems* serve a single block, thermal *efficiency* or heating COP shall be based on a weighted average using heating capacity.
d. Where multiple *boiler*s or chillers serve a heating-water or chilled-water loop, *efficiency* shall be based on a weighted average for using heating or cooling capacity.
e. When multiple cooling towers serving a condenser water loop are combined, the cooling tower *efficiency*, cooling tower design approach, and design range are based on a weighted average of the design water flow rate through each cooling tower.
f. Where multiple *pumps* serve a heating-water, chilled-water, or condenser water loop, *pump* power shall be based on a weighted average for using design water flow rate.
g. When multiple *system* types with and without economizers are combined, the economizer maximum *outdoor air* fraction of the combined *system* shall be based on weighted average of 100% supply air for *systems* with economizers and design *outdoor air* for *systems* without economizers.
h. Multiple *systems* with and without ERVs cannot be combined.

Table J2.2.3 Proposed Building HVAC System Parameters (I-P)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
HVAC System Type	*System* type	User defined	Selected from Table J1.1.1	All
System Sizing	Design-day information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone coil capacity	Fixed	Sizing factors used are 1.25 for heating *equipment* and 1.15 for cooling *equipment.*	All
	Supply airflow	Fixed	Based on the greater of a supply-air-to-room-air temperature *set point* difference of 20°F or required *OA ventilation*	
Outdoor *Ventilation* Air and Filtration	Portion of supply air with proposed filter ≥MERV 13	User defined	Percentage of supply airflow subject to higher filtration (adjusts reference fan power higher; prorated)	All
	Outdoor *ventilation* supply airflow rate adjustments	Fixed	Basis is 1.0 zone air distribution effectiveness	All
	Outdoor *ventilation* supply airflow rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed *DCV control* (See "Demand Control Ventilation" category below.)	All
System Operation	*Space* temperature *set points*	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except for hotel/motel, which shall be 70°F heating 72°F cooling	All
	Fan operation—occupied (where DOAS meets *ventilation* requirements)	User defined	Fan either runs continuously during occupied hours or is cycled to meet thermal load.	All (continuous) 1–11 (cycles)
	Fan operation—occupied (where heating and cooling units provide *ventilation*—no DOAS)	Fixed	Fan runs continuously during occupied hours; *VAV* or multispeed fans reduce airflow related to thermal load.	1–11
	Fan operation—night cycle	Fixed	Fan cycles ON to meet *setback* temperatures.	1–11
Packaged *Equipment Efficiency*	DX cooling *efficiency*	User defined	Cooling *COP* without fan *energy* calculated in accordance with Section J4.2.3(d)	1, 2, 3, 4, 5, 7, 8, 9, 11, 12
	DX coil number of stages	User defined	Single stage or multistage	3, 4, 9, 10, 11, 12
	Heat-*pump efficiency*	User defined	Heating *COP* without fan *energy* calculated in accordance with Section J4.2.3(d)	2, 4, 5, 7, 8, 12
	Furnace *efficiency*	User defined	Furnace thermal *efficiency*	1, 3, 9, 12
Heat-*Pump* Supplemental Heat	Heat source	User defined	*Electric resistance* or gas furnace	2, 4, 7, 8, 12
	Control	Fixed	*Electric* heat locked out above 40°F OAT. Runs as needed in conjunction with compressor between 40°F and 0°F. Gas heat operates in place of the heat pump when the heat pump cannot meet load.	2, 4, 7, 8, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (I-P)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
System Fan Power and Controls	Design fan power, W/cfm	User defined	Input electric power for all fans required to operate at *fan system design conditions* divided by the supply airflow rate. Include any VSD losses at design condition. This is a wire-to-air value, including all drive, motor *efficiency*, and other losses.	All

	Part-load fan controls:
	• Constant volume
	• Two-speed or three-speed, then input:
	  • W/cfm at each speed
	  • % cfm at leach speed
	• *VAV*
		User defined	Static pressure reset included for *VAV*	All (constant volume, two speed)
				9, 10, 11 (*VAV*)

Variable-Air-Volume Systems	SAT *controls* (select): • None • OAT SAT reset • Warmest zone SAT reset	User defined	If not SAT reset, then constant at 55°F. Options for reset based on OAT or warmest zone. If OAT reset, SAT is reset higher to 60°F at outdoor low of 50°F. SAT is 55°F at outdoor high of 70°F. If warmest zone, then the user can specify the minimum and maximum temperatures.	9, 10, 11
	• Zone minimum damper and E_{vs} • Standard 62.1 simple method except for schools	Fixed	• Schools: 1.2 × V_{oz} zone minimum design *ventilation* rate, cfm; E_{vs} = 0.65 • Other *buildings*: Simple Standard 62.1 method is 1.5 × V_{oz} zone minimum design *ventilation* rate, cfm; E_{vs} = 0.75.	9, 10, 11
	Dual *set point* minimum *VAV* damper position	User defined	Heating minimum and maximum airflow fraction	9, 10, 11
	Terminal-unit heating source	User defined	Electric or hydronic	
	FPTU type	User defined	Series or parallel FPTU	11
	Parallel FPTU fan		Sized for 50% peak primary air at 0.35 W/cfm	11
	Series FPTU fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
Economizer	OSA economizer presence	User defined	Yes or no	3, 4, 5, 6, 9, 10, 11
	Economizer high limit	Fixed	• Lockout on differential dry-bulb temperature (OAT > RAT) in Climate Zones 6A, 5A, All B, and C • Fixed enthalpy > 28 Btu/lb or fixed dry-bulb OAT > 75°F in Climate Zones 0A to 4A	
Energy Recovery	Sensible effectiveness	User defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent effectiveness	User defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Bypass SAT *set point*	User defined	If bypass, target supply air temperature	3, 4, 9, 10, 11, 12
	Fan power reduction when in bypass	User defined	If bypass, specify fan power reduction, W/cfm.	3, 4, 9, 10, 11, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (I-P)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
Demand Control Ventilation	*DCV* application ON/OFF	User defined	Percentage of block floor area under occupied standby controls, ON/OFF only (see Section 6.5.3.8) with no variable control	3, 4, 9, 10, 11, 12
	DCV application CO_2	User defined	Percentage of block floor area under variable *DCV* control (CO_2); may include both variable and ON/OFF control	3, 4, 9, 10, 11, 12
Dedicated *Outdoor Air System*	DOAS fan power, W/cfm	User defined	Fan electrical input power in W/cfm of supply airflow	12
	DOAS supplemental heating and cooling	User defined	Heating source, cooling source, energy recovery, and respective *efficiencies*	12
	Maximum SAT *set point* (cooling)	User defined	SAT *set point* if DOAS includes supplemental cooling	12
	Minimum SAT *set point* (heating)	User defined	SAT *set point* if DOAS includes supplemental heating	12
Heating Plant	*Boiler efficiency*	User defined	*Boiler* thermal *efficiency*	1, 6, 7, 9, 10, 11, 12
	HW loop configuration	User defined	Variable-flow primary only; variable-flow primary and secondary; constant-flow primary and variable-flow secondary	1, 6, 7, 9, 10, 11, 12
	HW primary *pump* power, W/gpm	User defined	HW constant primary *pump* input W/gpm HW flow	1, 6, 7, 9, 10, 11, 12
	HW secondary *pump* power, W/gpm	User defined	HW variable secondary *pump* input W/gpm HW flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	HW loop temperature	User defined	HW supply and return temperatures, °F	1, 6, 7, 9, 10, 11, 12
	HW temperature reset included	User defined	Yes/no	1, 6, 7, 9, 10, 11, 12
	HWST reset	Fixed	Reset HWST by 27.3% of design temperature difference (HWST – 70°F *space* heating temperature *set point*) between 20°F and 50°F OAT	1, 6, 7, 9, 10, 11, 12
	Boiler type	Fixed	Regular where input thermal *efficiency* is less than 86%; condensing *boiler* otherwise	1, 6, 7, 9, 10, 11, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (I-P)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
Chilled-Water Plant	Chiller condenser type	User defined	Air-cooled or water-cooled; for water-cooled, positive displacement or centrifugal	6, 10, 11, 12
	Chiller full-load *efficiency*	User defined	Chiller *COP*	6, 10, 11, 12
	Number of chillers	User defined	In simulation, chillers will be sized equally with 1–3 chillers.	6, 10, 11, 12
	CHW coil design temperature difference, °F	User defined	CHWST and CHW return temperature at design conditions	6, 10, 11, 12
	CHW loop configuration	User defined	Variable-flow primary only; variable-flow primary and secondary; constant-flow primary and variable-flow secondary	6, 10, 11, 12
	CHW primary *pump* power, W/gpm	User defined	Primary *pump* input, W/gpm; CHW flow	6, 10, 11, 12
	CHW secondary *pump* power, W/gpm	User defined	Secondary *pump* input, W/gpm; CHW flow (if primary/secondary)	6, 10, 11, 12
	CHW temperature reset included	User defined	Yes/no	6, 10, 11, 12
	CHW temperature reset schedule	Fixed	*OA* reset: Use input CHWST at 80°F *outdoor air* dry-bulb and above and CHWST 10°F at 60°F *OA* dry-bulb and below, ramped linearly between	6, 10, 11, 12
Condenser Loop	Condenser water-*pump* power, W/gpm	User defined	*Pump* input, W/gpm; condenser water flow	6, 7, 8, 10, 11, 12
	Condenser water-*pump* control	Fixed	Constant-speed, one *pump* per chiller	6, 7, 8, 10, 11, 12
Heat Rejection	Heat-rejection equipment *efficiency*	User defined	gpm/hp at design conditions, where hp is the sum of nameplate fan and integral spray *pump* motor hp, if applicable	6, 7, 8, 10, 11, 12
	Open-circuit cooling tower flow turndown	Fixed	Flow turndown per Section 6.5.5.4	6, 7, 8, 10, 11, 12
	Heat-rejection fan control	User defined	Constant or variable speed	6, 7, 8, 10, 11, 12
	Heat-rejection approach and range	User defined	Design heat-rejection approach and range temperature	6, 7, 8, 10, 11, 12
Heat-Pump Loop	Loop flow and heat-pump control valve	Fixed	Two-position valve with VSD on *pump*	7, 8
	Heat-pump loop flow control	Fixed	Loop flow at 3 gpm/ton	7, 8
	Heat-*pump* loop minimum and maximum temperature control	User defined	User input; restrict to minimum 20°F and maximum 40°F temperature difference.	7, 8
Ground-Loop Heat-Pump Bore Field		Fixed	Bore depth = 250 ft; bore length 200 ft/ton for greater of cooling or heating load	8
			Bore spacing = 15 ft	
			Bore diameter = 5 in. with 3/4 in. nominal diameter polyethylene pipe	
			Ground and grout conductivity = 4.8 Btu·in./h·ft^2·°F	

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (SI)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
HVAC System Type	*System* type	User defined	Selected from Table J1.1.1	All
System Sizing	Design-day information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone coil capacity	Fixed	Sizing factors used are 1.25 for heating *equipment* and 1.15 for cooling *equipment*	All
	Supply airflow	Fixed	Based on the greater of a supply-air-to-room-air temperature *set point* difference of 11°C or required *OA ventilation*	
Outdoor *Ventilation* Air and Filtration	Portion of supply air with proposed filter ≥MERV 13	User defined	Percentage of supply airflow subject to higher filtration (adjusts reference fan power higher; prorated)	All
	Outdoor *ventilation* supply airflow rate adjustments	Fixed	Basis is 1.0 zone air distribution effectiveness	All
	Outdoor *ventilation* supply airflow rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed *DCV control* (See "Demand Control Ventilation" category below.)	All
System Operation	*Space* temperature *set points*	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except for hotel/motel, which shall be 21°C heating 22°C cooling	All
	Fan operation—occupied (where DOAS meets *ventilation* requirements)	User defined	Fan either runs continuously during occupied hours or is cycled to meet thermal load	All (continuous) 1–11 (cycles)
	Fan operation—occupied (where heating and cooling units provide *ventilation*—no DOAS)	Fixed	Fan runs continuously during occupied hours; *VAV* or multispeed fans reduce airflow related to thermal load	1–11
	Fan operation—night cycle	Fixed	Fan cycles ON to meet *setback* temperatures	1–11
Packaged *Equipment Efficiency*	DX cooling *efficiency*	User defined	Cooling *COP* without fan *energy* calculated in accordance with Section J4.2.3(d)	1, 2, 3, 4, 5, 7, 8, 9, 11, 12
	DX coil number of stages	User defined	Single stage or multistage	3, 4, 9, 10, 11, 12
	Heat-*pump efficiency*	User defined	Heating *COP* without fan *energy* calculated in accordance with Section J4.2.3(d)	2, 4, 5, 7, 8, 12
	Furnace *efficiency*	User defined	Furnace thermal *efficiency*	1, 3, 9, 12
Heat-*Pump* Supplemental Heat	Heat source	User defined	*Electric resistance* or gas furnace	2, 4, 7, 8, 12
	Control	Fixed	*Electric* heat locked out above 4°C OAT. Runs as needed in conjunction with compressor between 4°C and –17.8°C. Gas heat operates in place of the heat pump when the heat pump cannot meet load.	2, 4, 7, 8, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (SI)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
System Fan Power and Controls	Design fan power, W·s/L	User defined	Input electric power for all fans required to operate at *fan system design conditions* divided by the supply airflow rate. Include any VSD losses at design condition. This is a wire-to-air value, including all drive, motor *efficiency*, and other losses.	All

	Part-load fan controls:
	• Constant volume
	• Two-speed or three-speed, then input:
	  • W·s/L at each speed
	  • % L/s at leach speed
	• *VAV*
		User defined	Static pressure reset included for *VAV*	All (constant volume, two speed)
				9, 10, 11 (*VAV*)

Variable-Air-Volume Systems	SAT *controls* (select): • None • OAT SAT reset • Warmest zone SAT reset	User defined	If not SAT reset, then constant at 12.8°C. Options for reset based on OAT or warmest zone. If OAT reset, SAT is reset higher to 15.6°C at outdoor low of 10°C. SAT is 12.8°C at outdoor high of 21.1°C. If warmest zone, then the user can specify the minimum and maximum temperatures.	9, 10, 11
	• Zone minimum damper and E_{vs} • Standard 62.1 simple method except for schools	Fixed	• Schools: 1.2 × V_{oz} zone minimum design *ventilation* rate, L/s; E_{vs} = 0.65 • Other *buildings*: Simple Standard 62.1 method is 1.5 × V_{oz} zone minimum design *ventilation* rate, L/s; E_{vs} = 0.75.	9, 10, 11
	Dual *set point* minimum *VAV* damper position	User defined	Heating minimum and maximum airflow fraction	9, 10, 11
	Terminal-unit heating source	User defined	Electric or hydronic	
	FPTU type	User defined	Series or parallel FPTU	11
	Parallel FPTU fan		Sized for 50% peak primary air at 0.74 W·s/L	11
	Series FPTU fan	Fixed	Sized for 50% peak primary air at 0.74 W·s/L	11
Economizer	OSA economizer presence	User defined	Yes or no	3, 4, 5, 6, 9, 10, 11
	Economizer high limit	Fixed	• Lockout on differential dry-bulb temperature (OAT > RAT) in Climate Zones 6A, 5A, All B, and C • Fixed enthalpy > 47 kJ/kg or fixed dry-bulb OAT > 24°C in Climate Zones 0A to 4A	
Energy Recovery	Sensible effectiveness	User defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent effectiveness	User defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Bypass SAT *set point*	User defined	If bypass, target supply air temperature	3, 4, 9, 10, 11, 12
	Fan power reduction when in bypass	User defined	If bypass, specify fan power reduction, W·s/L.	3, 4, 9, 10, 11, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (SI)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
Demand Control Ventilation	*DCV* application ON/OFF	User defined	Percentage of block floor area under occupied standby controls, ON/OFF only (see Section 6.5.3.8) with no variable control	3, 4, 9, 10, 11, 12
	DCV application CO_2	User defined	Percentage of block floor area under variable *DCV* control (CO_2); may include both variable and ON/OFF control	3, 4, 9, 10, 11, 12
Dedicated *Outdoor Air System*	DOAS fan power, W·s/L	User defined	Fan electrical input power in W·s/L of supply airflow	12
	DOAS supplemental heating and cooling	User defined	Heating source, cooling source, energy recovery, and respective *efficiencies*	12
	Maximum SAT *set point* (cooling)	User defined	SAT *set point* if DOAS includes supplemental cooling	12
	Minimum SAT *set point* (heating)	User defined	SAT *set point* if DOAS includes supplemental heating	12
Heating Plant	*Boiler efficiency*	User defined	*Boiler* thermal *efficiency*	1, 6, 7, 9, 10, 11, 12
	HW loop configuration	User defined	Variable-flow primary only; variable-flow primary and secondary; constant-flow primary and variable-flow secondary	1, 6, 7, 9, 10, 11, 12
	HW primary *pump* power, W·s/L	User defined	HW constant primary *pump* input W·s/L HW flow	1, 6, 7, 9, 10, 11, 12
	HW secondary *pump* power, W·s/L	User defined	HW variable secondary *pump* input W·s/L HW flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	HW loop temperature	User defined	HW supply and return temperatures, °C	1, 6, 7, 9, 10, 11, 12
	HW temperature reset included	User defined	Yes/no	1, 6, 7, 9, 10, 11, 12
	HWST reset	Fixed	Reset HWST by 27.3% of design temperature difference (HWST – 21°C *space* heating temperature *set point*) between –6.7°C and 10°C OAT	1, 6, 7, 9, 10, 11, 12
	Boiler type	Fixed	Regular where input thermal *efficiency* is less than 86%; condensing *boiler* otherwise	1, 6, 7, 9, 10, 11, 12

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J2.2.3 Proposed Building HVAC System Parameters (SI)

Category	Parameter	Fixed or User Defined	Required	Applicable Systems[a]
Chilled-Water Plant	Chiller condenser type	User defined	Air-cooled or water-cooled; for water-cooled, positive displacement or centrifugal	6, 10, 11, 12
	Chiller full-load *efficiency*	User defined	Chiller *COP*	6, 10, 11, 12
	Number of chillers	User defined	In simulation, chillers will be sized equally with 1–3 chillers.	6, 10, 11, 12
	CHW coil design temperature difference, °C	User defined	CHWST and CHW return temperature at design conditions	6, 10, 11, 12
	CHW loop configuration	User defined	Variable-flow primary only; variable-flow primary and secondary; constant-flow primary and variable-flow secondary	6, 10, 11, 12
	CHW primary *pump* power, W·s/L	User defined	Primary *pump* input, W·s/L; CHW flow	6, 10, 11, 12
	CHW secondary *pump* power, W·s/L	User defined	Secondary *pump* input, W·s/L; CHW flow (if primary/secondary)	6, 10, 11, 12
	CHW temperature reset included	User defined	Yes/no	6, 10, 11, 12
	CHW temperature reset schedule	Fixed	*OA* reset: Use input CHWST at 27°C *outdoor air* dry-bulb and above and CHWST – 12°C at 16°C *OA* dry-bulb and below, ramped linearly between.	6, 10, 11, 12
Condenser Loop	Condenser water-*pump* power, W·s/L	User defined	*Pump* input, W·s/L; condenser water flow	6, 7, 8, 10, 11, 12
	Condenser water- *pump* control	Fixed	Constant-speed, one *pump* per chiller	6, 7, 8, 10, 11, 12
Heat Rejection	Heat-rejection equipment *efficiency*	User defined	L/s·*kW* at design conditions, where hp is the sum of nameplate fan and integral spray *pump* motor hp, if applicable	6, 7, 8, 10, 11, 12
	Open-circuit cooling tower flow turndown	Fixed	Flow turndown per Section 6.5.5.4	6, 7, 8, 10, 11, 12
	Heat-rejection fan control	User defined	Constant or variable speed	6, 7, 8, 10, 11, 12
	Heat-rejection approach and range	User defined	Design heat-rejection approach and range temperature	6, 7, 8, 10, 11, 12
Heat-*Pump* Loop	Loop flow and heat-pump control valve	Fixed	Two-position valve with VSD on *pump*	7, 8
	Heat-pump loop flow control	Fixed	Loop flow at 0.054 L/s·*kW*	7, 8
	Heat-*pump* loop minimum and maximum temperature control	User defined	User input; restrict to minimum 11°C and maximum 22°C temperature difference.	7, 8
Ground-Loop Heat-Pump Bore Field		Fixed	Bore depth = 76.2 m; bore length 17.3 m/*kW* for greater of cooling or heating load	8
			Bore spacing = 4.6 m	
			Bore diameter = 127 mm with 25 mm nominal diameter polyethylene pipe	
			Ground and grout conductivity = 0.69 W/m·°C	

a. Applicable systems from Table J1.1.1

Informative Note: See Section 3.3 for a full list of terms used in this table.

i. *Systems* with and without supply air temperature reset cannot be combined.
j. *Systems* with different fan *control* (constant volume, multispeed, or *VAV*) for supply fans cannot be combined.

J3. SIMULATION PROGRAM

The *simulation program* shall have the following capabilities:

J3.1 Calculation of the TSPR. The *simulation program* shall calculate both the *$TSPR_p$* and *$TSPR_r$* based only on the input for the *proposed design* and the requirements of this appendix. The calculation procedure shall not allow the user to directly modify either the *building* component characteristics of the *TSPR reference building design* or the HVAC parameters identified as fixed input in Table J2.2.3.

J3.2 TSPR Simulation Program. All components of the *proposed design* for blocks served by *HVAC systems* using this method shall be explicitly modeled by the *simulation program*. The *code official* shall be permitted to approve a *simulation program* for a specified application or limited scope.

J3.2.1 Minimum Capability. The *simulation program* shall be approved by the *code official* and shall, at a minimum, have the ability to explicitly model all of the following:

a. 8760 hours per year
b. Hourly variations in occupancy, lighting power, miscellaneous *equipment* power, *thermostat set points*, and *HVAC system* operation, defined separately for each day of the week and holidays
c. Thermal mass effects
d. Ten or more *thermal blocks*
e. Part-load performance curves or other part-load adjustment methods for mechanical *equipment*
f. Capacity and *efficiency* correction curves or other part-load adjustment methods for *mechanical heating* and *mechanical cooling equipment*
g. *Air economizers* with integrated controls
h. The *energy* use of all *HVAC system* types included in the analysis and *energy* impact from all related fixed and user inputs in Table J2.2.3
i. Ability to automatically generate the *TSPR reference building design* as specified in Section J4.3

Informative Note: The *simulation program* shall include clear prompts or accessible help-topic references defining specific parameters and units for all required *building* and *system* characteristic inputs.

J3.2.2 TSPR Determination. The *simulation program* shall have the ability to either directly determine the *$TSPR_p$* and *$TSPR_r$* or produce hourly and annual reports of *energy* use by each *energy* source suitable for determining the *$TSPR_p$* and *$TSPR_r$* using a separate calculation.

J3.2.3 Load Calculations. The *simulation program* shall be capable of performing design load calculations to determine required HVAC *equipment* capacities and air and water flow rates in accordance with Section 6.4.2.1 for both the *proposed design* and *TSPR reference building design*.

J3.2.4 Testing

J3.2.4.1 The *simulation program* shall be tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140. The required tests shall include *building* thermal envelope and fabric load tests (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC *equipment* analytical verification tests (Section 5.5) along with the associated reporting (Section 6).

J3.2.4.2 The test results and modeler reports shall be posted on a publicly available website and shall include the test results of the *simulation program* and input files used for generating the results along with the results of the other *simulation programs* included in ASHRAE Standard 140, Annexes B8 and B16. The modeler report in Standard 140, Annex A2, Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.

Informative Notes:

1. There are no pass/fail criteria established by this testing requirement.
2. Based on the Section 3.2 definition, *simulation program* includes the simulation engine and the corresponding user interface. The testing of a *simulation program* only meets the requirements of Section J3 for that *simulation program* and cannot be used as proxy for documenting compliance of another *simulation program* that uses the same simulation engine.

J3.3 Climatic Data. Climatic data shall meet the requirements of Section G2.3.

J3.4 Compliance Report. The *simulation program* shall generate a report that includes the following:

a. Address of the *building*
b. Name of individual completing the compliance report
c. Name and version of the compliance *simulation program,* the edition of Standard 90.1 the *simulation program* method complies with, and the link to the website that contains the ASHRAE Standard 140 testing results for the version used in accordance with Section J.3.2.4
d. The dimensions, floor heights, and number of *floors* for each block
e. By block, the *U-factor*, *C-factor*, or *F-factor* for each simulated *opaque building envelope* component and the *U-factor* and *SHGC* for each *fenestration* component
f. By block or by surface for each block, the *fenestration* area and total area of each *opaque building envelope* component
g. By block, a list of the HVAC *equipment* simulated in the *proposed design,* including the *equipment* type, fuel type, rated *equipment efficiencies*, rated capacities, and *system* control parameters
h. Annual site HVAC *energy* use by end use and *energy* type for the *proposed design* and *TSPR reference building design*
i. Annual sum of hourly heating and cooling loads for the *TSPR reference building design*
j. The HVAC *total system performance ratio* for both the *TSPR reference building design* and the *proposed design* and compliance result in accordance with Section 6.6.2.2

Informative Note: The *simulation program*, at a minimum, will report compliance with the *TSPR* based on the compliance criteria in Section 6.2.2.2. Should a jurisdiction adopt other compliance criteria, then a separate calculation of *TSPR* using the *reference building design* and *proposed design* HVAC *energy* type input may be necessary.

J4. CALCULATION PROCEDURE

Except as specified by this appendix, the *TSPR reference building design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

J4.1 Simulation of the Proposed Design (Non-HVAC). The *proposed design* non-*HVAC systems* shall be configured and analyzed as specified in this section. At a minimum, the *simulation program* shall support the *building* use types included in the analysis. The allowed *building* use types are listed in Section J1.1.1.1.

J4.1.1 Simplified Block Approach. The *simulation program* shall model the *building* using one or more simplified geometric simulation *building* blocks, described in Section J2.1. Each block contains one or multiple *thermal blocks*. The *simulation program* shall provide for simplified input described in Section J2.2 and allow for multiple block simulation.

J4.1.2 Thermal Zoning. Each *floor* in a block shall be modeled as a single *thermal block* or as five *thermal blocks* consisting of four perimeter zones and a core zone. Below-*grade floors* shall always be modeled as a single block. If any façade in the block is less than 45 ft (13.7 m) in length, there shall only be a single *thermal block* per *floor*. Otherwise, each *floor* shall be modeled with five *thermal blocks*. A perimeter zone shall be created extending from each façade to a default depth of 15 ft (4.6 m) with a user input range of 8 to 20 ft (2.4 to 6.1 m). 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*.

J4.1.3 Building Use Type. The *building* use type for each block shall be consistent with the *proposed design* and allowed *building* use types in Section J1.1.1.1. The occupant density, heat gain, and schedule shall be as specified by Normative Appendix C.

J4.1.4 Building Envelope Components. *Building envelope* thermal properties used in the *proposed design* shall be modeled based on the actual *proposed design* using inputs described in Section J2.2.2 and shall comply with all of the following:

a. *Roofs* shall be modeled with insulation above a steel *roof* deck. *Roof* solar absorptance shall be modeled at 0.70 and thermal *emittance* at 0.90.
b. *Above-grade walls* shall be modeled as steel-frame construction.
c. Above-*grade* exterior *floors* shall be modeled as steel-frame construction.
d. The area, *U-factor*, and *SHGC* of vertical *fenestration* shall be modeled for each façade based on the actual *proposed design*. The *simulation program* shall model a combined single window centered on each façade based on the area and sill height input by the user.
e. The *skylight* area shall be modeled for each *roof* based on the actual *proposed design*. *Skylights* shall be combined into a single *skylight* centered on the *roof* of each zone based on the area input by the user.

Table J4.2.3-1 Fan and *Pump* Power Curve Coefficients

Equation Term	Fan Power Coefficients		*Pump* Power Coefficients	
	VSD (no Static Pressure Reset)	VSD + Static Pressure Reset	Ride *Pump* Curve	VSD + Differential Pressure/Valve Reset
b	0.0013	0.0408	0	0
x	0.147	0.088	3.2485	0.0205
x^2	0.9506	–0.0729	–4.7443	0.4101
x^3	–0.0998	0.9437	2.5295	0.5753

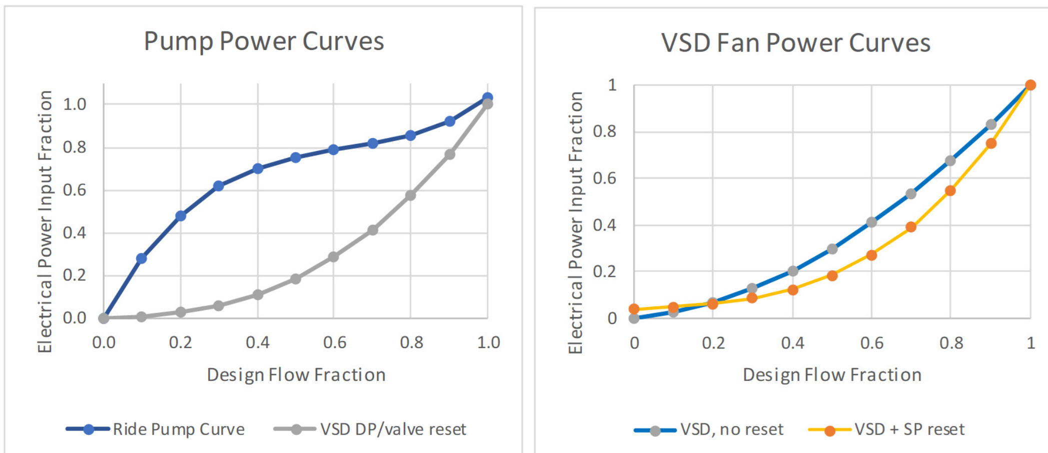


Figure J4.2.3-1 Fan and *pump* power performance as a function of design water flow or airflow.

J4.1.5 Lighting. For each block, the interior *lighting power density* shall be equal to the applicable allowance in Table 9.5.1 based on the assigned *building* use type. The lighting profile schedule shall be for the applicable *building* use type as specified by Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule, and no explicit controls (including daylighting controls) shall be modeled. Exterior lighting shall not be modeled.

J4.1.6 Miscellaneous Equipment. The miscellaneous *equipment* schedule and power shall be based on the assigned *building* use type as specified by Normative Appendix C. The impact of miscellaneous *equipment* controls is assumed to be captured by the *equipment* schedule, and no explicit controls shall be modeled.

J4.1.7 Elevators. Elevators shall not be modeled.

J4.1.8 Service Water-Heating Equipment. *Service water heating* shall not be modeled.

J4.1.9 On-site Renewable Energy Systems. *On-site renewable energy systems* shall not be modeled.

J4.2 Simulation of the Proposed Design (HVAC). The *proposed design HVAC systems* shall be configured and analyzed as specified in this section.

J4.2.1 HVAC Equipment. The *simulation program* shall analyze the *control* parameters that meet the mandatory requirements of Section 6.4 and the parameters provided by the user or specified as fixed in Section J2.2.3 as applicable for each *HVAC system* included in the *proposed design*.

J4.2.2 Supported HVAC Systems. The *HVAC systems* included in the *proposed design* and the *TSPR reference building design* shall be supported by the *simulation program*. *HVAC systems* permitted are limited to those shown in Table J1.1.1. The *simulation program* shall support multiple blocks being served by one central *system*.

J4.2.3 Proposed Building HVAC System Simulation. The *HVAC systems* shall be modeled as in the *proposed design* with clarifications and simplifications as described in Table J2.2.3 and the following rules:

a. *System* parameters not described in Table J2.2.3 and the following sections shall be simulated to meet the minimum requirements of Section 6.4.
b. Where multiple *system* components serve a block, average values weighed by the appropriate metric as described in Section J2.2.3.1 shall be used.
c. Heat loss from ducts and pipes shall not be modeled.

Table J4.2.3-2 DCV Outdoor Air Reduction Curve Coefficients

Equation Term	*DCV OA* Reduction (*y*) as a Function of *DCV* Effective Controlled Floor Area (*x*)			
	Office	School	Hotel, Motel, Multifamily, Dormitory	Retail
b	0	0	0	0
x	0.4053	0.2676	0.5882	0.4623
x^2	–0.8489	0.7753	–1.0712	–0.848
x^3	1.0092	–1.5165	1.3565	1.1925
x^4	–0.4168	0.7136	–0.6379	–0.5895

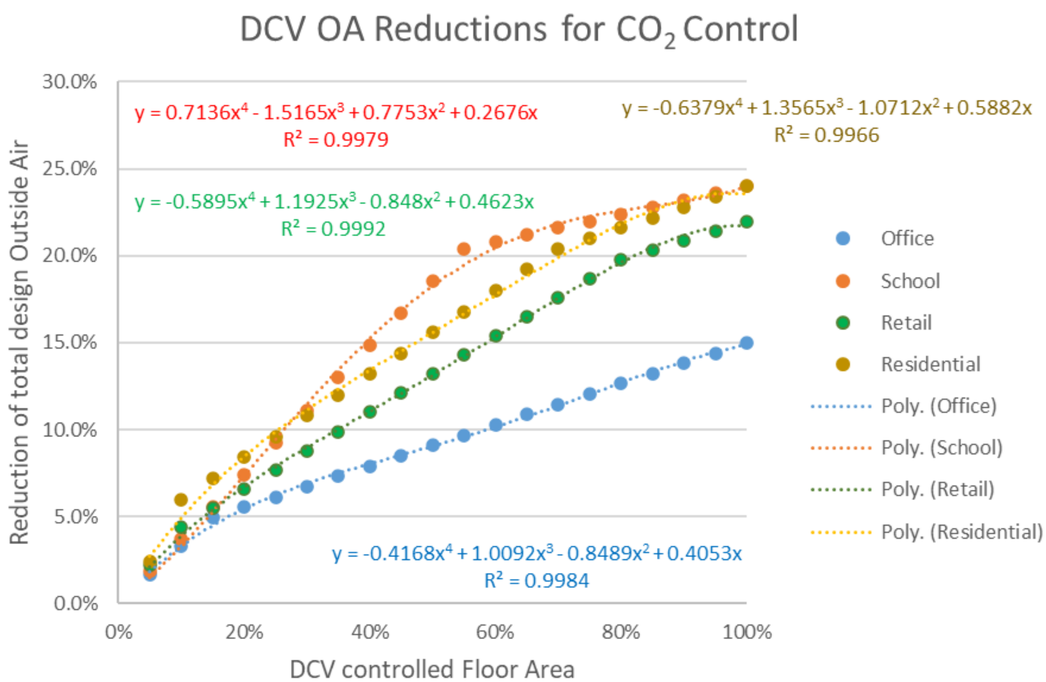


Figure J4.2.3-2 DCV OA reduction as a function of controlled floor area.

d. 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.

e. Part-load variable-speed fan and *pump* power shall be calculated using a cubic function with coefficients as shown in Table J4.2.3-1. The independent variable shall be the fraction of design water flow rate for *pumps* and the fraction of design airflow rate for fans as shown in Figure J4.2.3-1.

f. *Demand control ventilation* shall be modeled using a simplified approach that adjusts the design outdoor supply airflow rate based on the area of the *building* that is covered by *DCV* with coefficients as shown in Table J4.2.3-2. The input shall accommodate two types of *DCV*:

1. Variable *control* based on people sensor response (CO_2 sensor or other)
2. ON/OFF occupied standby *control* that closes the *VAV* box primary air damper or shuts off *outdoor air* when the zone is completely unoccupied based on an *occupancy sensor* (See Section 6.5.3.8.)

(Informative Note: Due to lower probability occurrence, the ON/OFF controls are given 1/3 the reduction of the CO_2 sensor *DCV*. The *outdoor air* reduction factor shall be based on a smaller area of *control* being applied to higher density *spaces* first, adjusted for *building* type, with *outdoor air* reduction factors and an application formula as shown.)

Table J4.3.2-1 TSPR Reference Building Design HVAC Complex Systems (I-P)

Building Type Parameter	Large Office (warm) [a]	Large Office (cold) [b]	School (warm) [a]	School (cold) [b]
System type	*VAV*/reheat water-cooled chiller/ electric reheat with parallel fan powered boxes	*VAV*/reheat water-cooled chiller/ gas *boiler*	*VAV*/reheat water-cooled chiller/ electric reheat with parallel fan powered boxes	*VAV*/reheat water-cooled chiller/ gas *boiler*
Fan control	VSD, no static pressure reset	VSD, no static pressure reset	VSD, no static pressure reset	VSD, no static pressure reset
Main fan power (W/cfm) proposed ≥MERV13	1.165	1.165	1.165	1.165
Main fan power (W/cfm) proposed <MERV13	1.066	1.066	1.066	1.066
Zonal fan power, W/cfm	0.35	NA	0.35	NA
Minimum zone airflow fraction	$1.5 \times V_{oz}$	$1.5 \times V_{oz}$	$1.2 \times V_{oz}$	$1.2 \times V_{oz}$
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A
Occupied *outdoor air* (= proposed)	Sum(V_{oz})/0.75	Sum(V_{oz})/0.75	Sum(V_{oz})/0.65	Sum(V_{oz})/0.65
Energy recovery ventilator enthalpy recovery ratio bypass; SAT *set point*	NA	NA	50%; no bypass	50%; 60°F except no bypass required in Climate Zone 4A
Demand control ventilation	No	No	No	No
Cooling source	2 water-cooled centrif. chillers	2 water-cooled centrif. chillers	2 water-cooled screw chillers	2 water-cooled screw chillers
Cooling *efficiency*	Table G3.5.3	Table G3.5.3	Table G3.5.3	Table G3.5.3
Heating source (reheat)	Electric resistance	Gas *boiler*	Electric resistance	Gas *boiler*
Furnace or *boiler efficiency*	1.0	75% E_t	1.0	80% E_t
Condenser heat rejection	Axial-fan open-circuit cooling tower			
Cooling-tower efficiency, gpm/hp (See Section G3.1.3.11)	38.2	38.2	38.2	38.2
Open-circuit cooling-tower turndown (>300 ton)	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant flow; 10°F range	Constant flow; 10°F range	Constant flow; 10°F range	Constant flow; 10°F range
Open-circuit cooling-tower approach	G3.1.3.11	G3.1.3.11	G3.1.3.11	G3.1.3.11
Cooling condenser pump power, W/gpm	19	19	19	19

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-1 TSPR Reference Building Design HVAC Complex Systems (I-P) *(Continued)*

Building Type Parameter	Large Office (warm) [a]	Large Office (cold) [b]	School (warm) [a]	School (cold) [b]
Cooling primary pump power, W/gpm	9	9	9	9
Cooling secondary pump power, W/gpm	13	13	13	13
Cooling-coil CHW temperature difference, °F	12	12	12	12
Design CHWST, °F	44	44	44	44
CHWST reset set point vs. OAT, °F	CHWST/OAT: 44–54/80–60 (See Normative Appendix G.)	CHWST/OAT: 44–54/80–60 (See Normative Appendix G.)	CHWST/OAT: 44–54/80–60 (See Normative Appendix G.)	CHWST/OAT: 44–54/80–60 (See Normative Appendix G.)
CHW-loop pumping *control*	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD
Heating-pump power, W/gpm	16.1	16.1	16.1	16.1
Heating-oil HW temperature difference, °F	50	50	50	50
Design HWST, °F	180	180	180	180
HWST reset *set point* vs. OAT, °F	HWST/OAT: 180–150/20–50	HWST/OAT: 180–150/20–50	HWST/OAT: 180–150/20–50	HWST/OAT: 180–150/20–50
HW-loop pumping *control*	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-1 TSPR Reference Building Design HVAC Complex Systems (SI)

Building Type Parameter	Large Office (warm) [a]	Large Office (cold) [b]	School (warm) [a]	School (cold) [b]
System type	*VAV*/reheat water-cooled chiller/ electric reheat with parallel fan powered boxes	*VAV*/reheat water-cooled chiller/ gas *boiler*	*VAV*/reheat water-cooled chiller/ electric reheat with parallel fan powered boxes	*VAV*/reheat water-cooled chiller/ gas *boiler*
Fan control	VSD, no static pressure reset	VSD, no static pressure reset	VSD, no static pressure reset	VSD, no static pressure reset
Main fan power (W·s/L) proposed ≥MERV13	2.485	2.485	2.485	2.485
Main fan power (W·s/L) proposed <MERV13	2.274	2.274	2.274	2.274
Zonal fan power, W·s/L	0.75	NA	0.75	NA
Minimum zone airflow fraction	$1.5 \times V_{oz}$	$1.5 \times V_{oz}$	$1.2 \times V_{oz}$	$1.2 \times V_{oz}$
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A
Occupied *outdoor air* (= proposed)	Sum(V_{oz})/0.75	Sum(V_{oz})/0.75	Sum(V_{oz})/0.65	Sum(V_{oz})/0.65
Energy recovery ventilator enthalpy recovery ratio bypass; SAT *set point*	NA	NA	50%; no bypass	50%; 60°F except 4A
Demand control ventilation	No	No	No	No
Cooling source	2 water-cooled centrif chillers	2 water-cooled centrif chillers	2 water-cooled screw chillers	2 water-cooled screw chillers
Cooling *efficiency*	Table G3.5.3	Table G3.5.3	Table G3.5.3	Table G3.5.3
Heating source (reheat)	Electric resistance	Gas *boiler*	Electric resistance	Gas *boiler*
Furnace or *boiler efficiency*	1.0	75% E_t	1.0	80% E_t
Condenser heat rejection	Axial-fan open-circuit cooling tower			
Cooling-tower efficiency, L/s·*kW* (See Section G3.1.3.11)	3.23	3.23	3.23	3.23
Open-circuit cooling-tower turndown (>1060 *kW*)	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant flow; 5.6°C range	Constant flow; 5.6°C range	Constant flow; 5.6°C range	Constant flow; 5.6°C range
Open-circuit cooling-tower approach	G3.1.3.11	G3.1.3.11	G3.1.3.11	G3.1.3.11
Cooling condenser pump power, W·s/L	300	300	300	300

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-1 TSPR Reference Building Design HVAC Complex Systems (SI) *(Continued)*

Building Type Parameter	Large Office (warm) [a]	Large Office (cold) [b]	School (warm) [a]	School (cold) [b]
Cooling primary pump power, W·s/L	142	142	142	142
Cooling secondary pump power, W·s/L	205	205	205	205
Cooling-coil CHW temperature difference, °C	6.7	6.7	6.7	6.7
Design CHWST, °C	6.7	6.7	6.7	6.7
CHWST reset set point vs. OAT, °C	CHWST/OAT: 6.7–12.2/26.7–15.6 (See Normative Appendix G.)	CHWST/OAT: 6.7–12.2/26.7–15.6 (See Normative Appendix G.)	CHWST/OAT: 6.7–12.2/26.7–15.6 (See Normative Appendix G.)	CHWST/OAT: 6.7–12.2/26.7–15.6 (See Normative Appendix G.)
CHW-loop pumping *control*	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD
Heating-pump power, W·s/L	254	254	254	254
Heating-coil HW temperature difference, °C	10	10	10	10
Design HWST, °C	82	82	82	82
HWST reset *set point* vs. OAT, °C	HWST/OAT: 82–65.6/–6.7–10	HWST/OAT: 82–65.6/–6.7–10	HWST/OAT: 82–65.6/–6.7–10	HWST/OAT: 82–65.6/–6.7–10
HW-loop pumping *control*	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD	Two-way valves and *pump* VSD

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-2 TSPR Reference Building Design HVAC Simple Systems 1 (I-P)

***Building* Type Parameter**	**Medium Office (warm)[a]**	**Medium Office (cold)[b]**	**Small Office (warm)[a]**	**Small Office (cold)[b]**	**Retail (warm)[a]**	**Retail (cold)[b]**
System type	Package *VAV*—electric reheat	Package *VAV*—hydronic reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD, no static pressure reset	VSD, no static pressure reset	Constant volume	Constant volume	Constant volume	Constant volume
Main fan power (W/cfm) proposed ≥MERV13	1.285	1.285	0.916	0.916	0.899	0.899
Main fan power (W/cfm) proposed <MERV13	1.176	1.176	0.850	0.850	0.835	0.835
Zonal fan power (W/cfm)	0.35	NA	NA	NA	NA	NA
Minimum zone airflow fraction	30%	30%	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<40°F OAT	NA	<40°F OAT	NA
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A	No	Yes except 4A
Occupied *outdoor air* source	Packaged unit, occupied damper, all *building* use types					
Energy recovery ventilator	No	No	No	No	No	No
Demand control ventilation	No	No	No	No	No	No
Cooling source	DX, multistage	DX, multistage	DX, single stage (heat *pump*)	DX, single stage	DX, single stage (heat *pump*)	DX, single stage
Cooling *COP* (net of fan)	3.40	3.40	3.00	3.00	3.40	3.50
Heating source	Electric resistance	Gas *Boiler*	Heat *Pump*	Furnace	Heat *Pump*	Furnace
Heating *COP* (net of fan)/furnace or *boiler efficiency*	1.0	75% E_t	3.40	80% E_t	3.40	80% E_t

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-2 TSPR Reference Building Design HVAC Simple Systems 1 (SI)

Building **Type Parameter**	**Medium Office (warm)[a]**	**Medium Office (cold)[b]**	**Small Office (warm)[a]**	**Small Office (cold)[b]**	**Retail (warm)[a]**	**Retail (cold)[b]**
System type	Package *VAV*—electric reheat	Package *VAV*—hydronic reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD, no static pressure reset	VSD, no static pressure reset	Constant volume	Constant volume	Constant volume	Constant volume
Main fan power (W·s/L) proposed ≥ MERV13	20.29	20.29	14.46	14.46	14.19	14.19
Main fan power (W·s/L) proposed < MERV13	18.59	18.59	13.42	13.42	13.42	13.42
Zonal fan power (W·s/L)	5.53	NA	NA	NA	NA	NA
Minimum zone airflow fraction	30%	30%	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<4.4°C OAT	NA	<4.4°C OAT	NA
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A	No	Yes except 4A
Occupied OSA source	Packaged unit, occupied damper, all *building* use types					
Energy recovery ventilator	No	No	No	No	No	No
Demand control ventilation	No	No	No	No	No	No
Cooling source	DX, multistage	DX, multistage	DX, single stage (heat *pump*)	DX, single stage	DX, single stage (heat *pump*)	DX, single stage
Cooling *COP* (net of fan)	3.40	3.40	3.00	3.00	3.40	3.50
Heating source	Electric resistance	Gas *Boiler*	Heat *Pump*	Furnace	Heat *Pump*	Furnace
Heating *COP* (net of fan)/furnace or *boiler efficiency*	1.0	75% E_t	3.40	80% E_t	3.40	80% E_t

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-3 TSPR Reference Building Design HVAC Simple Systems 2 (I-P)

***Building* Type Parameter**	**Hotel (warm)[a]**	**Hotel (cold)[b]**	**Multifamily (warm)[a]**	**Multifamily (cold)[b]**
System type	*PTHP*	*PTAC*	*PTHP*	*PTAC*
Fan control	Constant volume	Constant volume	Constant volume	Constant volume
Main fan power, W/cfm	0.300	0.300	0.300	0.300
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<40°F	NA	<40°F	NA
Outdoor air economizer	No	No	No	No
Occupied *outdoor air* source	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No	No	No
Demand control ventilation	No	No	No	No
Cooling source	DX, single stage (heat *pump*)	DX, single stage	DX, single stage (heat *pump*)	DX, single stage
Cooling *COP* (net of fan)	3.10	3.20	3.10	3.20
Heating source	*PTHP*	2 hydronic *boilers*	*PTHP*	2 hydronic *boilers*
Heating *COP* (net of fan)/furnace or *boiler efficiency*	3.10	75% E_t	3.10	75% E_t
Heating pump power, W/gpm	NA	19	NA	19
Heating-coil HW temperature difference, °F	NA	50	NA	50
Design HWST, °F	NA	180	NA	180
HWST reset *set point* vs. OAT, °F	NA	HWST/OAT: 180–150/20–50	NA	HWST/OAT: 180–150/20–50
HW-loop pumping *control*	NA	Two-way valves and ride *pump* curve	NA	Two-way valves and ride *pump* curve

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J4.3.2-3 TSPR Reference Building Design HVAC Simple Systems 2 (SI)

***Building* Type Parameter**	**Hotel (warm)[a]**	**Hotel (cold)[b]**	**Multifamily (warm)[a]**	**Multifamily (cold)[b]**
System type	*PTHP*	*PTAC*	*PTHP*	*PTAC*
Fan control	Constant volume	Constant volume	Constant volume	Constant volume
Main fan power, W·s/L	4.74	4.74	4.74	4.74
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<4.4°C	NA	<4.4°C	NA
Outdoor air economizer	No	No	No	No
Occupied *outdoor air* source	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No	No	No
Demand control ventilation	No	No	No	No
Cooling source	DX, single stage (heat *pump*)	DX, single stage	DX, single stage (heat *pump*)	DX, single stage
Cooling *COP* (net of fan)	3.10	3.20	3.10	3.20
Heating source	*PTHP*	2 hydronic *boilers*	*PTHP*	2 hydronic *boilers*
Heating *COP* (net of fan)/furnace or *boiler efficiency*	3.10	75% E_t	3.10	75% E_t
Heating pump power, W·s/L	NA	300	NA	300
Heating-coil HW temperature difference, °C	NA	27.8	NA	27.8
Design HWST, °C	NA	82.2	NA	82.2
HWST reset *set point* vs. OAT, °C	NA	HWST/OAT: 82–65.6/–6.7–10	NA	HWST/OAT: 82–65.6/–6.7–10
HW-loop pumping *control*	NA	Two-way valves and ride *pump* curve	NA	Two-way valves and ride *pump* curve

a. "Warm" refers to Climate Zones 0 through 2 and 3A.
b. "Cold" refers to Climate Zones 3B, 3C, and 4 through 8.
Informative Note: See Section 3.3 for a full list of terms used in this table.

Table J5-1 Energy Conversion Factors for HVAC Energy Input[a] (I-P)

Building Project *Energy* Source	Units	*Energy* Cost, $/unit	*Energy* Cost, $/1000 site Btu
Electricity	kWh	$0.1099	$32.21
Natural gas	therm	$0.983	$9.83
Propane	therm	$0.983	$9.83
Distillate fuel oil	gal	$1.353	$9.83

a. *Energy* input conversion factors are based on U.S. averages. Nonelectric heating prices are based on blended heating prices adjusted for the U.S. average mix of heating fuels. These prices are applied to fuel output per unit.

Table J5-1 Energy Conversion Factors for HVAC Energy Input[a] (SI)

Building Project *Energy* Source	Units	*Energy* Cost, $/unit	*Energy* Cost, $/site GJ
Electricity	kWh	$0.1099	$32.21
Natural gas	*GJ*	$9.32	$9.32
Propane	*GJ*	$9.32	$9.32
Distillate fuel oil	L	$0.357	$9.32

a. *Energy* input conversion factors are based on U.S. averages. Nonelectric heating prices are based on blended heating prices adjusted for the U.S. average mix of heating fuels. These prices are applied to fuel output per unit.

Informative Table J5-2 Energy Conversion Factors for HVAC Energy Input[a] (I-P)

Building Project *Energy* Source	Units	Carbon Emissions (CO_2e), lb/unit	Site *Energy*, Btu/unit	Source *Energy*, Btu/unit
Electricity	kWh	1.418	3412	9008
Natural gas	therm	19.960	100,000	109,000
Propane	therm	19.080	100,000	115,000
Distillate fuel oil	gal	28.830	137,600	163,744

a. *Energy* input conversion factors are based on ASHRAE Standard 189.1-2020. They represent average U.S. values and may be replaced with local values.

Informative Table J5-2 Informative Energy Conversion Factors for HVAC Energy Input[a] (SI)

Building Project *Energy* Source	Units	Carbon Emissions (CO_2e), kg/unit	Site *Energy*, W·h/unit	Source *Energy*, W·h/unit
Electricity	kWh	0.643	1000	2640
Natural gas	*GJ*	85.833	277,778	302,778
Propane	*GJ*	76.367	277,778	319,445
Distillate fuel oil	L	13.077	10,651	12,674

a. *Energy* input conversion factors are based on ASHRAE Standard 189.1-2020. They represent average U.S. values and may be replaced with local values.

For office, school, and retail:

$$\textit{DCV}\text{ Effective Controlled Floor Area} = \text{Area}_{VarDCV} + 1/3 \times \text{Area}_{ON\text{-}OFF} \text{ AND Area}_{ON\text{-}OFF} < 1 - \text{Area}_{VarDCV}$$

For hotel, motel, dormitory, and multifamily:

$$\textit{DCV}\text{ Effective Controlled Floor Area} = \text{Area}_{VarDCV} + \text{Area}_{ON\text{-}OFF}$$

where

Area_{VarDCV} = fraction of block floor area with variable sensor-based *DCV control*

$\text{Area}_{ON\text{-}OFF}$ = fraction of block floor area with only occupied standby *control* as defined in Section 6.5.3.8 that does not also have variable sensor-based *demand control ventilation*.

Informative Table J5-3 Mechanical Performance Factors (MPF), Carbon Emission Basis

	Climate Zone																		
***Building* Type**	**0A**	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Office (small and medium) [a]	0.72	0.72	0.70	0.71	0.69	0.65	0.71	0.67	0.63	0.73	0.66	0.69	0.76	0.70	0.71	0.79	0.75	0.80	0.82
Office (large) [a]	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.83	0.78	0.68	0.79	0.66	0.72	0.74	0.66	0.73	0.72	0.71	0.70
Retail	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.47	0.38	0.42	0.48	0.54	0.42	0.55	0.54	0.46	0.41	0.42	0.37
Hotel/motel	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.55	0.64	0.61	0.49	0.55	0.63	0.45	0.48	0.41	0.34
Apartment/dormitory	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.69	0.55	0.57	0.55	0.49	0.57	0.51	0.44	0.56	0.52	0.53	0.50
School/education	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.68	0.68	0.71	0.65	0.75	0.70	0.61	0.79	0.73	0.75	0.71

a. Office sizes defined in Section J1.1.1.1.

Informative Table J5-4 Mechanical Performance Factors (MPF), Site Energy Basis

	Climate Zone																		
***Building* Type**	**0A**	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Office (small and medium [a]	0.72	0.72	0.70	0.71	0.69	0.65	0.71	0.68	0.65	0.81	0.70	0.78	0.85	0.77	0.81	0.87	0.84	0.88	0.90
Office (large) [a]	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.81	0.77	0.67	0.76	0.63	0.71	0.72	0.63	0.73	0.71	0.71	0.71
Retail	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.51	0.40	0.45	0.57	0.68	0.46	0.68	0.67	0.50	0.45	0.44	0.38
Hotel/motel	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.45	0.59	0.52	0.38	0.47	0.51	0.35	0.38	0.31	0.26
Apartment/dormitory	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.72	0.55	0.53	0.50	0.44	0.54	0.47	0.38	0.55	0.50	0.51	0.47
School/education	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.67	0.73	0.72	0.68	0.82	0.73	0.61	0.89	0.80	0.83	0.77

a. Office sizes defined in Section J1.1.1.1.

Informative Table J5-5 Mechanical Performance Factors (MPF), Source Energy Basis

	Climate Zone																		
***Building* Type**	**0A**	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Office (small and medium) [a]	0.72	0.72	0.70	0.71	0.69	0.65	0.71	0.67	0.63	0.71	0.66	0.68	0.75	0.69	0.69	0.77	0.73	0.78	0.81
Office (large) [a]	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.83	0.78	0.68	0.79	0.67	0.72	0.75	0.66	0.73	0.72	0.71	0.70
Retail	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.47	0.38	0.41	0.47	0.52	0.42	0.53	0.52	0.45	0.40	0.41	0.37
Hotel/motel	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.56	0.65	0.63	0.51	0.57	0.65	0.47	0.50	0.43	0.36
Apartment/dormitory	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.68	0.54	0.58	0.56	0.50	0.57	0.51	0.46	0.56	0.52	0.54	0.51
School/education	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.68	0.68	0.71	0.65	0.74	0.69	0.61	0.78	0.71	0.74	0.70

a. Office sizes defined in Section J1.1.1.1.

J4.3 Simulation of the TSPR Reference Building Design. The *TSPR reference building design* shall be configured and analyzed as specified in this section.

J4.3.1 Non-HVAC Inputs. Utility rates, blocks, *HVAC zones*, *building* use types, schedules, occupant density, heat gains, *building envelope* components, lighting power, and miscellaneous *equipment loads* shall be modeled the same as in the *proposed design.*

Elevators, *service water-heating equipment*, and *on-site renewable energy systems* shall not be modeled; same as in the *proposed design*.

J4.3.2 HVAC Equipment. The *TSPR reference building design* HVAC *equipment* consists of separate *space* conditioning *systems* and DOASs as described in Table J4.3.2-1 through Table J4.3.2-3 for the appropriate *building* use types. Variable-speed drive fan and *pump* power shall be modeled using parameters in Table J4.2.3-1. HVAC *equipment* shall be modeled at minimum *efficiency* based on specified *efficiency* metrics in Table J4.3.2-1 through Table J4.3.2-3. Where available in Normative Appendix G, *equipment*-type-specific part-load performance adjustments shall be used; otherwise, typical part-load performance adjustments shall be used.

J5. TSPR METRIC FOR SITE HVAC ENERGY INPUT

For purposes of calculating *TSPR* for the *proposed design* and the *TSPR reference building design*, the calculated HVAC *energy* input of each *building* project *energy* source shall be converted to cost using the *energy* cost prices from Table J5-1.

Informative Notes:

1. The blended heating prices in Table J5-1 that are used for fossil fuels are not intended to represent actual average prices, but to represent a consistent blended price per 1000 Btu (GJ) used. This will avoid requiring the simulation program to run the reference systems with a fossil fuels type that matches the proposed building. The common price per site fuel Btu (GJ) allows proposed *system efficiency* to be properly compared with the reference *system*.
2. Informative Tables J5-2 through J5-5 include values for alternate *energy* input metrics that may be adopted by a jurisdiction. If so, the jurisdiction should replace the *TSPR energy* input of *energy* cost in Section J5 with the alternate metric and should include appropriate metric values from Informative Table J5-2 into Table J5-1. The jurisdiction should replace the MPF values in Table 6.6.2.2 with one of the following:
   - For carbon emissions, replace Table 6.6.2.2 MPF values with those in Informative Table J5-3. This table allows users to compare the quantity of carbon dioxide emissions generated by the *proposed design building* to the target building. For compliance purposes, it is intended for use in voluntary standards and in jurisdictions where the use of a carbon emissions metric is not preempted by U.S. federal law.
   - For source *energy*, replace Table 6.6.2.2 MPF values with those in Informative Table J5-4.
   - For site *energy*, replace Table 6.6.2.2 MPF values with those in Informative Table J5-5.

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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As an industry leader in research, standards writing, publishing, certification, and continuing education, ASHRAE and its members are dedicated to promoting a healthy and sustainable built environment for all, through strategic partnerships with organizations in the HVAC&R community and across related industries.

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