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6.7 HVAC Secondary Systems

This group of building descriptors relate to the secondary HVAC systems. There is not a one-to-one relationship between secondary HVAC system components in the proposed design and the baseline building since the baseline building system is determined from building type, size and heating source. Appendix A shows the applicability of each building descriptor for the eight baseline building systems. Depending on the nature of the proposed design, any of the building descriptors could apply.

6.7.1 Basic System Information

HVAC System Name

Applicability

All system types

A unique descriptor for each HVAC System

Units Text, unique

Input Restrictions When applicable, this input should match the tags that are used on the plans.

Baseline Rules None

System Type

Applicability All system types

Definition A unique descriptor which identifies the following attributes of an HVAC System:

- Number of air decks (one to three);
- Constant or variable air flow;
- Type of terminal device; and
- Fan configuration for multiple deck systems.

Units None

Input Restrictions As designed

Baseline Rules Based on the prescribed system type (see Figure 6.1.2-1 [1]). The baseline system types are shown in the table below.

Table 6.7.1-1: *"Baseline Building System Type"*

Baseline Building System	System Type
System 1 – PTAC	Single Zone Heating and Cooling
System 2 – PTHP	Single Zone Heating and Cooling
System 3 – PSZ-AC	Single Zone Heating and Cooling
System 4 – PSZ-HP	Single Zone Heating and Cooling
System 5 – Packaged VAV with Reheat	Single Duct VAV
System 6 – Packaged VAV with PFP boxes	Single Duct VAV
System 7 – VAV with Reheat	Single Duct VAV
System 8 – VAV with PFP boxes	Single Duct VAV

Total Cooling Capacity

Applicability

All system types

Definition The installed cooling capacity of the project. This includes all:

- Chillers;
- Built-up DX; and,
- Packaged cooling units.

Units Cooling tons (12,000 Btu/h per ton)

Input Restrictions As designed. This could be calculated by the program from the proposed design building description or a separate load calculation may be used. Unmet load hours for the simulation shall not exceed 300 annually. Weather conditions used in sizing runs shall be based on 1% dry-bulb and 1% wet-bulb cooling design temperatures.

Baseline Rules	Autosize. The cooling capacity shall be oversized by 15%. If the number of unmet load hours of the proposed design exceeds the number of unmet load hours of the baseline by more than 50, decrease the cooling capacity as indicated in Figure 2.4-1 [2] and Figure 2.5.2-1 [3].

6.7.2 System Controls

Schedules

Cooling Schedule	
Applicability	All cooling systems
Definition	A schedule that represents the availability of cooling
Units	Data structure: schedule, on/off
Input Restrictions	For tax deduction calculations, the fan schedules from Tables 12 through 16 of Appendix C shall be used for cooling availability. For green building ratings and Design to Earn ENERGY STAR, the schedules in Appendix C shall be used as a default. The cooling availability schedule shall be consistent with the supply fan schedule and thermostat schedules to reduce the likelihood of unmet load hours.
Baseline Rules	Same as the proposed design

Heating Schedule	
Applicability	All systems
Definition	A schedule that represents the availability of heating
Units	Data structure: schedule, on/off
Input Restrictions	For tax deduction calculations, the schedules from Tables 12 through 16 of Appendix C shall be used. For green building ratings and Design to Earn ENERGY STAR, the schedules in Appendix C shall be used as a default. The heating availability schedule shall be consistent with the supply fan schedule.
Baseline Rules	Same as the proposed design

Air-Handler Schedule	
Applicability	All systems that do not cycle with loads
Definition	A schedule that indicates when the air handler operates continuously
Units	Data structure: schedule, on/off
Input Restrictions	For the purpose of tax deduction calculations, the fan schedule is prescribed. One of the schedules from Appendix C, Tables 12-16 shall be used. For green building ratings and Design to Earn ENERGY STAR, the schedules in Appendix C are defaults, but other schedules may be used when detailed information is known about the proposed design. When a fan system serves several occupancies, the fan schedule must remain ON to serve the operating hours of each occupancy.
Baseline Rules	Same as the proposed design

Air Handler Fan Cycling	
Applicability	All fan systems
Definition	This building descriptor indicates whether the system supply fan operates continuously or cycles with building loads. The fan systems in most commercial buildings operate continuously.
Units	List: continuous or cycles with loads
Input Restrictions	Continuous fan operation during occupied periods is a prescribed input, except for hotel guest rooms and high-rise residential. For these building types, continuous operation is the default, however, the option to let the fan cycle with loads may be used when the following conditions are met and documented: • The spaces served by the system are located within 25 ft of an operable window. • The openable window area is at least 4% of the floor space. • Other requirements for natural ventilation specified in ASHRAE Standard 62.1-2007, Section 5.1 are satisfied. For natural ventilation systems, an air conditioner is modeled in the proposed design even though one is not specified for the proposed design. This fan in the simulated air conditioner is allowed to cycle with loads since the simulated air conditioner is assumed to operate only when natural ventilation is unable to satisfy thermal comfort.
Baseline Rules	Same as proposed design, except for natural ventilation, in which case the fans in the baseline building are assumed to operate continuously

Optimum Start Control	
Applicability	Systems with the control capability for flexible scheduling of system start time based on building loads.
Definition	Optimum start control adjusts the start time of the HVAC unit such that the space is brought to setpoint just prior to occupancy. This control strategy modifies the heating, cooling, and fan schedules.
Units	Boolean (Yes/No)
Input Restrictions	As designed

Input Restrictions As designed

Baseline Rules The baseline building shall have optimum start controls when the baseline building design supply airflow is greater than 10,000 cfm.

Night-Cycle HVAC Fan Control

Applicability All systems

Definition The control of an HVAC system that is triggered by the heating or cooling temperature setpoint for thermal blocks during periods when the heating, cooling and fan systems are scheduled to be off. The choices are:

- Cycle on call from any zone
- Cycle on call from the primary control zone
- Stay off
- Cycle zone fans only (for systems with fan-powered boxes) Restart fans below given ambient temperature.

Units None

Input Restrictions As designed. However, night-cycle control shall be cycled on call from any zone for heating in climate zones 2 through 8, and for cooling in climate zones 1b, 2b, and 3b.

Baseline Rules Cycle on call from any zone

Cooling Control

Cooling Supply Air Temperature

Applicability Applicable to all systems

Definition The supply air temperature setpoint at design cooling conditions

Units Degrees Fahrenheit (°F)

Input Restrictions As designed

Baseline Rules 20°F lower than the design room air temperature

Cooling Supply Air Temperature Control

Applicability Any system with multiple cooling stages or unloading

Definition The method of controlling the supply air temperature. Choices are:

- Fixed (constant)
- Reset by warmest zone
- Reset by outside air dry-bulb temperature
- Scheduled setpoint

Units List (see above)

Input Restrictions As designed

Baseline Rules For baseline building systems 1 through 4, the SAT control is not applicable. For systems 5 through 8, the SAT control shall be reset by outside dry-bulb temperature.

Cooling Reset Schedule by OSA

Applicability When the proposed design resets SAT by outside air dry-bulb temperature

Definition A linear reset schedule that represents the SAT setpoint as a function of outdoor air dry-bulb temperature. This schedule is defined by the following data points (see Figure 6.7.2-1 [4]):

- The coldest cooling supply air temperature
- The corresponding (hot) outdoor air dry-bulb setpoint
- The warmest cooling supply air temperature
- The corresponding (cool) outdoor air dry-bulb setpoint

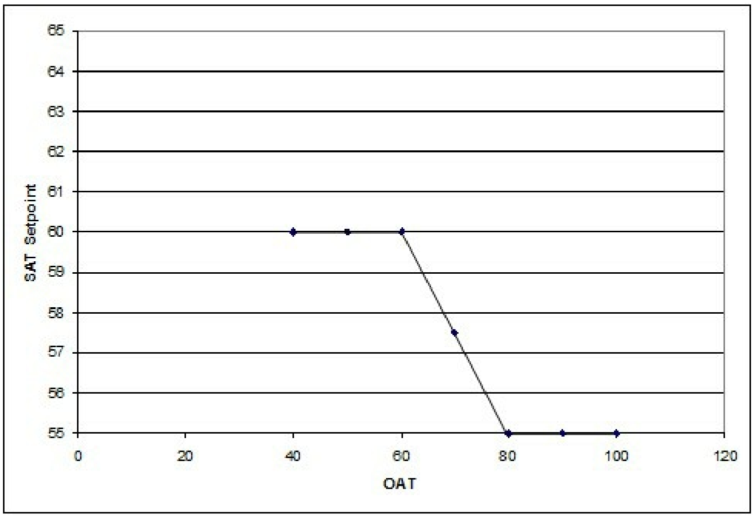

Figure 6.7.2-1: *"SAT Cooling Setpoint Reset based on Outdoor Air Temperature (OAT) for Dry (B) and Marine (C) Climates"*

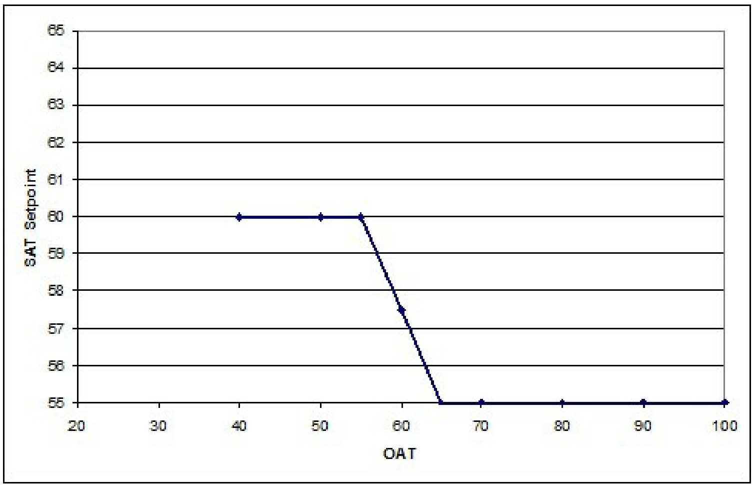

Figure 6.7.2-2: *"SAT cooling setpoint reset based on outdoor air temperature for humid 'A' climates"*

Units	Data structure (two matched pairs of SAT and OAT, see above)
Input Restrictions	As designed
Baseline Rules	Applicable for baseline building systems 5 through 8. For these systems, the minimum SAT shall be equal to the design conditions SAT when OAT is equal to or greater than 80 F. The maximum SAT shall be 5 F greater than the minimum when the OAT is 60 F or less.

Heating Control

Preheat Setpoint

Applicability	Systems with a preheat coil located in the outside air stream
Definition	The control temperature leaving the preheat coil
Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed
Baseline Rules	Same as the proposed design

Heating Supply Air Temperature

Applicability	All systems
Definition	The supply air temperature leaving the air handler when the system is in a heating mode (not the air temperature leaving the reheat coils in VAV boxes)
Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed
Baseline Rules	110°F for system types 1-4; 70°F for system types 5-8

Heating Supply Air Temperature Control

Applicability — Systems with the capability to vary heating SAT

Definition — The method of controlling heating SAT. Choices are:

- Fixed (constant)
- Reset by coldest zone
- Reset by outside air dry-bulb temperature
- Scheduled setpoint

Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed
Baseline Rules	Fixed (constant)

Heating Reset Schedule by OSA

Applicability — Systems that reset the heating SAT by outside dry-bulb temperature (this typically applies to dual-duct systems or to single zone systems with hydronic heating coils)

Definition — A linear reset schedule that represents the heating supply air temperature or hot deck supply air temperature (for dual duct systems) as a function of outdoor air dry-bulb temperature. This schedule is defined by the following data points (see Figure 6.7.2-3 [5]):

- The hottest heating supply air temperature
- The corresponding (cold) outdoor air dry-bulb threshold
- The coolest heating supply air temperature
- The corresponding (mild) outdoor air dry-bulb threshold

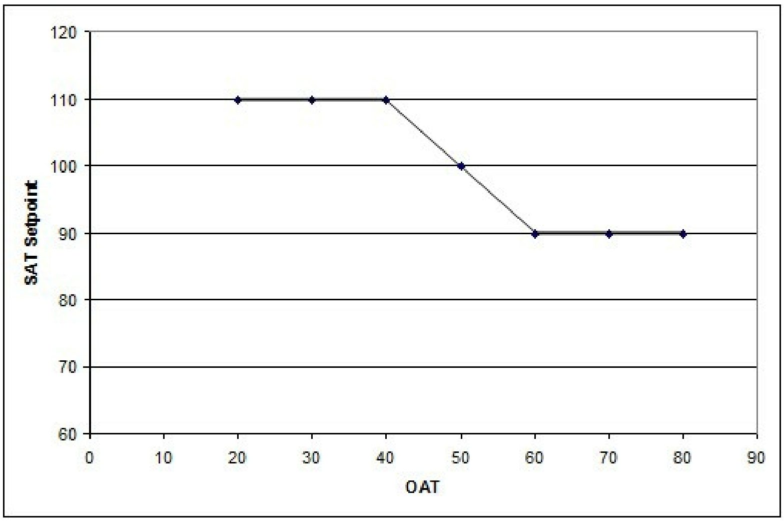

Figure 6.7.2-3: *"Example of SAT heating setpoint reset based on outdoor air temperature (OAT)."*

Units	Data structure (°F)
Input Restrictions	As designed
Baseline Rules	Not applicable

Night Purge

The baseline building does not have night purge controls. If the software supports it and the proposed design has the features, the following keywords may be used to model night purge. Note that night purge is coupled with thermal mass in the building, which is specified by other building descriptors.

Night Purge Availability Schedule	
Applicability	Systems that operate the fans for nighttime purge of heat gains
Definition	A schedule which represents the availability of night purge controls.
Units	Data structure: schedule, on/off
Input Restrictions	As designed. The default is no night purge control.
Baseline Rules	Not applicable

Night Purge Control	
Applicability	Systems that operate the fans for nighttime purge of heat gains
Definition	The control strategy for operation of nighttime purge. The control strategy may take account of indoor temperature, season, indoor temperature and other factors.
Units	Data structure
Input Restrictions	As designed
Baseline Rules	Not applicable

Night Purge Fan Ratio	
Applicability	Systems that operate the fans for nighttime purge of heat gains
Definition	The ratio of fan speed for a night purge cycle.
Units	Ratio
Input Restrictions	As designed. The default is 100% (or fans available at full speed).
Baseline Rules	Not applicable

6.7.3 Fan Systems

Baseline Building Fan System Summary

The baseline building fan system is summarized in this section. See Figure 6.1.2-1 [1] for the HVAC baseline building system mapping.

Total baseline building fan system power for the baseline building fan systems is given in Table 6.7.3-1 [6] for ASHRAE Standard 90.1-2007 and Table 6.7.3-2 [7] for ASHRAE Standard 90.1-2001. In these tables, "cfms" is the supply fan air flow at peak design conditions. This is calculated for the baseline building with the sizing procedure described in Figure 2.4-1 [2] and Figure 2.5.2-1 [3]. This brake horsepower includes the supply fan, the return fan, and exhaust fans. Exhaust fans include kitchen hoods, toilets, fume hoods, and other miscellaneous fans that operate at design conditions.

Table 6.7.3-1: *"Baseline Building Fan System – ASHRAE Standard 90.1-2007"*

	System Types 1-2	System Types 3-4	System Types 5-8
Brake Horsepower (bhp)	Not applicable	0.00094 x cfm_s + A	0.0013 x cfm_s + A
Fan Motor Efficiency (hm)	Not applicable	ASHRAE Standard 90.1-2007, Table 10.8	ASHRAE Standard 90.1-2007, Table 10.8
Fan Power (W)	0.3 x cfm_s	(bhp x 746)/*TeX Embedding failed!*m	(bhp x 746)/*TeX Embedding failed!*m
The term "A" for system types 3-8, is calculated based on equipment in the proposed design using the procedure in Table 6.5.3.1.1B of ASHRAE Standard 90.1-2007. This accounts for various additional fan pressure drops associated with special conditions.			

Table 6.7.3-2: *"Baseline Building Fan System – ASHRAE Standard 90.1-2001"*

	Fan Size	System Types 1-4	System Types 5-8
Nameplate Horsepower (nhp)	< 20,000 cfm	0.0012 x cfms + P_{filter} + $P_{process}$ + P_{relief}	0.0017 x cfm_s + P_{filter} + $P_{process}$ + P_{relief}
	=> 20,000 cfm	0.0011 x cfm_s + P_{filter} + $P_{process}$ + P_{relief}	0.0015 x cfm_s + P_{filter} + $P_{process}$ + P_{relief}
Fan Motor Efficiency (hm)		ASHRAE Standard 90.1-2001, Table 10.2	ASHRAE Standard 90.1-2001, Table 10.2
Brake Horsepower (bhp)		nhp x *TeX Embedding failed!*m	nhp x *TeX Embedding failed!*m
Fan Power (W)		(bhp x 746)/ *TeX Embedding failed!*m	(bhp x 746)/ *TeX Embedding failed!*m
The terms Pfilter, Pprocess, and Prelief account for additional pressure drop. These are based on features in the proposed design such as special filtration, process fans, and relief or return fans. See Section 6.3.3.1 of ASHRAE Standard 90.1-2001 and the associated User's Manual for details on how to calculate these adders.			

When the proposed design has exhaust fans (toilets or kitchens), return fans, or fume hood exhaust systems, the baseline building has the same systems. The brake horsepower determined from Table 6.7.3-1 [6] and Table 6.7.3-2 [7] is allocated to these baseline building fan systems proportionally to the allocation in the proposed design. The allocation of brake horsepower to the supply fan, the return and any exhaust or fume hood fans is based on the ratios described below.

Supply Fan Ratio

Applicability	Systems that serve thermal blocks that have exhaust, fume hoods, kitchen exhaust or return fans
Definition	The ratio of supply fan brake horsepower in the proposed design to total fan system brake horsepower for the proposed design at design conditions
Units	Unitless ratio
Input Restrictions	Derived from other building descriptors
Baseline Rules	Same as proposed design

Return Fan Ratio

Applicability	Systems that serve thermal blocks that have exhaust, fume hoods, kitchen exhaust or return fans
Definition	The ratio of return fan brake horsepower in the proposed design to total fan system brake horsepower for the proposed design at design conditions
Units	Unitless ratio
Input Restrictions	Derived from other building descriptors
Baseline Rules	Same as proposed design

Exhaust Fan Ratio

Applicability	Systems that serve thermal blocks that have exhaust, fume hoods, kitchen exhaust or return fans
Definition	The ratio of exhaust fan brake horsepower in the proposed design to total fan system brake hp for the proposed design at design conditions. Exhaust fans include toilet exhaust, kitchen hoods and other miscellaneous exhaust. Fume hood exhaust is treated separately.
Units	Unitless ratio
Input Restrictions	Derived from other building descriptors. In the event that a common exhaust system serves thermal blocks that are served by different HVAC systems, the brake horsepower shall be divided in proportion to design cfm.
Baseline Rules	Same as proposed design

Supply Fans

Fan System Modeling Method

Applicability All fan systems

Definition

Software commonly models fans in three ways.

- Power-per-unit-flow. The simple method is for the user to enter the electric power per unit of flow (W/cfm). This method is commonly used for unitary equipment and other small fan systems.

- Static pressure. A more detailed method is to model the fan as a system whereby the static pressure, fan efficiency, part-load curve, and motor efficiency are specified at design conditions.
- Break horsepower. A third method is to specify brake horsepower at design conditions instead of fan efficiency and static pressure. This is a variation of the second method whereby brake horsepower is specified in lieu of static pressure and fan efficiency. The latter two methods are commonly used for VAV and other larger fan systems.

Units List: power-per-unit-flow, static pressure or brake horsepower

Input Restrictions As designed. The power-per-unit-flow method shall be used when no fan performance data is available for the proposed design cooling system, e.g. only EER or SEER are available.

Baseline Rules If the proposed design uses the power-per-unit-flow method, the baseline building shall also use this method, otherwise the baseline building shall use the brake horsepower method.

Supply Fan Design Air Rated Capacity

Applicability All fan systems

Definition The design air flow rate of the supply fan(s) at design conditions. This building descriptor sets the 100% point for the fan part-load curve.

Units cfm

Input Restrictions As designed. This input should be at least as great as the sum of the design air flow specified for each of the thermal blocks that are served by the fan system. For multiple deck systems, a separate entry should be made for each deck.

Baseline Rules The program shall automatically size the air flow at each thermal block to meet the loads. The design air flow rate calculation shall be based on a 20 degree temperature differential between supply air and the room air. The supply fan design air flow rate shall be the sum of the calculated design air flow for the thermal blocks served by the fan system.

Fan Control Method

Applicability All fan systems

Definition A description of how the supply (and return/relief) fan(s) are controlled. The options include:

- Constant volume
- Variable-flow, inlet or discharge dampers
- Variable-flow, inlet guide vanes
- Variable-flow, variable speed drive (VSD)
- Variable-flow, variable pitch blades
- Variable-flow, other
- Two-speed
- Constant volume, cycling (fan cycles with heating and cooling)

Units List (see above)

Input Restrictions As designed

Baseline Rules Applicable to variable air volume systems
Based on the prescribed system type. Refer to the HVAC System Map in Figure 6.1.2-1 [1].

Table 6.7.3-3: *"Baseline Building Fan Control Method"*

Baseline building System	Fan Control Method
System 1 – PTAC	Constant volume
System 2 – PTHP	Constant volume
System 3 – PSZ-AC	Constant volume
System 4 – PSZ-HP	Constant volume
System 5 – Packaged VAV with Reheat	Variable-flow, variable speed drive (VSD)
System 6 – Packaged VAV with PFP boxes	Variable-flow, variable speed drive (VSD)
System 7 – VAV with Reheat	Variable-flow, variable speed drive (VSD)
System 8 – VAV with PFP boxes	Variable-flow, variable speed drive (VSD)

Supply Fan Brake Horsepower

Applicability All fan systems, except those specified using the power-per-unit-flow method

Definition The design shaft brake horsepower of the supply fan(s). This input does not need to be supplied if the Supply Fan kW is supplied.

Units Horsepower (hp)

Input Restrictions As designed. If this building descriptor is specified for the proposed design, then the *Static Pressure* and *Fan Efficiency* are not.

Baseline Rules See Table 6.7.3-1 [6] for ASHRAE Standard 90.1-2007 and Table 6.7.3-2 [7] for ASHRAE Standard 90.1-2001. These tables give the baseline building fan system brake horsepower. The brake horsepower for the supply fan is this value times the Supply Fan Ratio (see above).

Supply Fan Static Pressure

Applicability All fan systems, except those specified using the power-per-unit-flow method

Definition The design static pressure for the supply fan. This is important for both fan electric energy usage and duct heat gain calculations.

Units	Inches of water column (in. H_20)
Input Restrictions	As designed. The design static pressure for the supply fan does not need to be specified if the supply fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When *Static Pressure* and *Fan Efficiency* are entered for the proposed design, the baseline building shall use *Brake Horsepower*.

Supply Fan Efficiency

Applicability	All fan systems, except those specified using the power-per-unit-flow method
Definition	The efficiency of the fan at design conditions
Units	Unitless
Input Restrictions	As designed. The supply fan efficiency does not need to be specified if the supply fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When *Static Pressure* and *Fan Efficiency* are entered for the proposed design, the baseline building shall use *Brake Horsepower*.

Supply Motor Efficiency

Applicability	All supply fans, except those specified using the power-per-unit-flow method
Definition	The full-load efficiency of the motor serving the supply fan
Units	Unitless
Input Restrictions	As designed. Not applicable when the power-per-unit-flow method is used.
Baseline Rules	From Table 10.8 of ASHRAE Standard 90.1-2007 or Table 10.2 of ASHRAE Standard 90.1-2001

Fan Position

Applicability	All supply fans
Definition	The position of the supply fan relative to the cooling coil. The configuration is either draw through (fan is downstream of the coil) or blow through (fan is upstream of the coil).
Units	List (see above)
Input Restrictions	As designed.
Baseline Rules	Draw through

Motor Position

Applicability	All supply fans
Definition	The position of the supply fan motor relative to the cooling air stream. The choices are: in the air stream or out of the air stream.
Units	List (see above)
Input Restrictions	As designed.
Baseline Rules	In the air stream

Fan Part-Flow Power Curve

Applicability	All variable flow fan systems
Definition	A part-load power curve which represents the percentage full-load power draw of the supply fan as a function of the percentage full-load air flow. The curve is typically represented as a quadratic equation with an absolute minimum power draw specified.
Units	Unitless ratio
Input Restrictions	

As designed. The default fan curve shall be selected from Equation (6.7.3-1) and Table 6.7.3-3 [8] for the type of fan specified in the proposed design.

(6.7.3-1)

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where

PLR	Ratio of fan power at part load conditions to full load fan power
PowerMin	Minimum fan power
FanRatio	Ratio of cfm at part-load to full-load cfm
a, b, c and d	Constants from Table 6.7.3-3 [8] below

Table 6.7.3-4: *"Fan Curve Default Values"*

Fan Type - Control Type	a	b	c	d	$\%Power_{Min}$
AF or BI riding the curve[a]	0.1631	1.5901	-0.8817	0.1281	70%

AF or BI with inlet vanes[a]	0.9977	-0.659	0.9547	-0.2936	50%
FC riding the curve[a]	0.1224	0.612	0.5983	-0.3334	30%
FC with inlet vanes[a]	0.3038	-0.7608	2.2729	-0.8169	30%
Vane-axial with variable pitch blades[a]	0.1639	-0.4016	1.9909	-0.7541	20%
Any fan with VSD (use for baseline building)[b]	**0.0013**	**0.1470**	**0.9506**	**-0.0998**	**20%**
VSD with static pressure reset[c]	-0.0031	0.0991	1.0268	-0.1128	20%

Data Sources:
a. ECB Compliance Supplement, public review draft, Version 1.2, March 1996, but adjusted to be relatively consistent with the curve specified in the PRM.
b. The fan curve for VSD is specified in Table G3.1.3.15
c. Advanced VAV System Design Guide, California Energy Commission, CEC Publication 500,-03-082 A-11, April 2005, but adjusted to be relatively consistent with the curve specified in the PRM..

Baseline Rules Not applicable for baseline building systems 1-4. The curve for VSD fans shall be used for baseline building systems 5-8 with no adjustment for static pressure setpoint reset.

Supply Fan kW

Applicability Fan systems that use the power-per-unit-flow method
Definition The supply fan power per unit of flow.
Units kW/cfm
Input Restrictions

As designed or specified in the manufacturers' literature. For units with rated total cooling capacities less than 120,000 Btu/h, the user may default to a value calculated as follows:

(6.7.3-2)

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where

Fan_{kw} The supply fan power (kW)

Q_{rated} The rated total cooling capacity (Btu/h)

Baseline Rules Applicable when the baseline building uses the power-per-unit-flow method. Fan power is determined using Table 6.7.3-1 [6] for ASHRAE Standard 90.1-2007 and Table 6.7.3-2 [7] for ASHRAE Standard 90.1-2001. This power is then multiplied by the supply fan ratio.

Relief Fans

The baseline building has a return fan when the baseline building system is type 3 through 8 and the proposed design has a return fan.

Plenum Zone

Applicability Any system with return ducts or return air plenum
Definition A reference to the thermal block that serves as return plenum or where the return ducts are located
Units Text, unique
Input Restrictions As designed
Baseline Rules Applicable when the baseline building has a return fan. Same as the proposed design when the proposed design has a plenum, otherwise, the return air ducts are assumed to be located in the space.

Return Air Path

Applicability Any system with return ducts or return air plenum
Definition Describes the return path for air. This can be one of the following: ducted return; plenum return; or direct-to-unit.
Units List (see above)
Input Restrictions As designed
Baseline Rules Applicable when the baseline building has a return fan. For baseline building systems 1 and 2, the return air path shall be direct-to-unit. For baseline building systems 3 through 8 and when the proposed design is direct-to-unit, the baseline building shall be ducted return, otherwise the baseline building return air path shall be same as proposed design.

Return/Relief Air Rated Capacity

Applicability All systems with a return or relief fan
Definition The design air flow fan capacity of the return or relief fan(s). This sets the 100% fan flow point for the part-load curve (see below).
Units cfm
Input Restrictions As designed
Baseline Rules Applicable when the baseline building has a return fan. The return fan air *Rated Capacity* shall be equal to the baseline

building supply fan capacity less exhaust air flow.

Return/Relief Fan Brake Horsepower	
Applicability	Any system with return or relief fans that uses the brake horsepower method
Definition	The design shaft brake horsepower of the return/relief fan(s)
Units	Brake horsepower (bhp)
Input Restrictions	As designed
Baseline Rules	Applicable when the baseline building has a return fan. The bhp of the return fan shall be the fan system brake horsepower (see Table 6.7.3-1 [6] and Table 6.7.3-2 [7]) times the return fan ratio. In other words, brake horsepower is allocated in proportion to the proposed design.

Return/Relief Design Static Pressure	
Applicability	Any system with return or relief fans that uses the static pressure method
Definition	The design static pressure for return fan system. This is important for both fan electric energy usage and duct heat gain calculations.
Units	Inches of water column (in. H_20)
Input Restrictions	As designed. The design static pressure for the return fan does not need to be specified if the return fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When *Static Pressure* and *Fan Efficiency* are entered for the proposed design, the baseline building shall use *Brake Horsepower*.

Return/Relief Fan Efficiency	
Applicability	Any system with return or relief fans that uses the static pressure method
Definition	The efficiency of the fan at design conditions
Units	Unitless
Input Restrictions	As designed. The return/relief fan efficiency does not need to be specified if the return fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When *Static Pressure* and *Fan Efficiency* are entered for the proposed design, the baseline building shall use *Brake Horsepower*.

Return/Relief Motor Efficiency	
Applicability	All return fans, except those specified using the power-per-unit-flow method
Definition	The full-load efficiency of the motor serving the supply fan
Units	Unitless
Input Restrictions	As designed. Not applicable when the power-per-unit-flow method is used.
Baseline Rules	From Table 10.8 of ASHRAE Standard 90.1-2007 or Table 10.2 of ASHRAE Standard 90.1-2001

Motor Position	
Applicability	All return fans
Definition	The position of the supply fan motor relative to the cooling air stream. The choices are: in the air stream or out of the air stream.
Units	List (see above)
Input Restrictions	As designed.
Baseline Rules	In the air stream

Fan Part-Flow Power Curve	
Applicability	All return fans for variable flow fan systems.
Definition	A part-load power curve which represents the percentage full-load power draw of the supply fan as a function of the percentage full-load air flow.
Units	Unitless ratio
Input Restrictions	As designed. The default fan curve shall be selected from Equation (6.7.3-1) and Table 6.7.3-3 [8] for the type of fan specified in the proposed design.
Baseline Rules	Not applicable for baseline building systems 1-4. The curve for VSD fans shall be used for baseline building systems 5-8 that have a return/relief fan.

Return/Relief Fan kW	
Applicability	Any system with a return fan
Definition	The supply fan power per unit of flow
Units	kW/cfm
Input Restrictions	As specified in the manufacturers' literature
Baseline Rules	Applicable when the baseline building uses the power-per-unit-flow method. Fan power is determined using Table 6.7.3-1 [6] for ASHRAE Standard 90.1-2007 and Table 6.7.3-2 [7] for ASHRAE Standard 90.1-2001. This power is then multiplied by the return fan ratio.

Exhaust Fan Systems

Exhaust fans include toilet exhaust, kitchen exhaust, as well as fume hoods in laboratories and other spaces. Some systems typically operate at constant flow, while flow varies for other systems depending on, for instance, the position of the sash for fume hoods. Exhaust fan flow is specified and scheduled for each thermal block. An exhaust fan system may serve multiple thermal blocks. The baseline building has exhaust fans when the proposed design has exhaust fans. The exhaust air flow is the same for the baseline building and the proposed design.

Exhaust Fan Name

Applicability	All exhaust systems serving multiple thermal blocks
Definition	A unique descriptor for each exhaust fan. This should be keyed to the construction documents, if possible, to facilitate plan checking. Exhaust rates and schedules at the thermal block level refer to this name.
Units	Text, unique
Input Restrictions	Where applicable, this should match the tags that are used on the plans.
Baseline Rules	The baseline building will have an exhaust system that corresponds to the proposed design. The name can be identical to that used for the proposed design or some other appropriate name may be used.

Exhaust Fan System Modeling Method

Applicability	All exhaust fan systems
Definition	Software commonly models fans in three ways. See definition for supply system modeling method.
Units	List: power-per-unit-flow, static pressure or brake horsepower
Input Restrictions	As designed
Baseline Rules	If the proposed design uses the power-per-unit-flow method, the baseline building shall also use this method, otherwise the baseline building shall use the brake horsepower method.

Exhaust Fan Rated Capacity

Applicability	All exhaust systems
Definition	The rated design air flow rate of the exhaust fan system. This building descriptor defines the 100% flow case for the part-flow curve. Actual air flow is the sum of the flow specified for each thermal block, as modified by the schedule for each thermal block.
Units	cfm
Input Restrictions	As designed
Baseline Rules	Same as proposed design

Fan Control Method

Applicability	All exhaust fan systems
Definition	A description of how the exhaust fan(s) are controlled. The options include: • Constant volume • Two-speed • Variable-flow, inlet or discharge dampers • Variable-flow, inlet guide vanes • Variable-flow, variable speed drive (VSD) • Variable-flow, variable pitch blades
Units	List (see above)
Input Restrictions	As designed, however, when exhaust fan flow at the thermal block level is varied through a schedule, one of the variable-flow options shall be specified.
Baseline Rules	The baseline building exhaust fan control shall generally be the same as the proposed design. For laboratories that have exhaust flow of 5,000 cfm or more, the baseline building exhaust flow shall vary in response to scheduled fume hood exhaust and lab zone airflow schedules. Fume hood exhaust flow control shall be the same as design, and general exhaust (relief) shall be VSD.

Exhaust Fan Schedule

Applicability	All exhaust fan systems
Definition	A schedule that indicates when the exhaust fan system is available for operation. Exhaust fan flow is specified at the thermal block level.
Units	Data structure: schedule, on/off
Input Restrictions	The exhaust fan system shall be available during all periods when one or more thermal blocks served by the system are scheduling exhaust.
Baseline Rules	Same as the proposed design

Exhaust Fan Brake Horsepower

Applicability	All exhaust fan systems
Definition	The design shaft brake horsepower of the exhaust fan(s).
Units	Brake horsepower (bhp)
Input Restrictions	As designed
Baseline Rules	The bhp for the baseline building is the total system fan horsepower from Table 6.7.3-1 [6] or Table 6.7.3-2 [7] times the exhaust fan ratio.

Exhaust Fan Design Static Pressure

Applicability	Any system with return or relief fans that uses the static pressure method
Definition	The design static pressure for exhaust fan system. This is important for both fan electric energy usage and duct heat gain calculations.

Units	Inches of water column (in. H_20)
Input Restrictions	As designed. The design static pressure for the exhaust fan does not need to be specified if the exhaust fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When static pressure and fan efficiency are entered for the proposed design, the baseline building shall use brake horsepower.

Exhaust Fan Efficiency

Applicability	Any exhaust fan system that uses the static pressure method
Definition	The efficiency of the exhaust fan at rated capacity
Units	Unitless
Input Restrictions	As designed. The exhaust fan efficiency does not need to be specified if the return fan brake horsepower (bhp) is specified.
Baseline Rules	Not applicable. When static pressure and fan efficiency are entered for the proposed design, the baseline building shall use brake horsepower.

Exhaust Fan Motor Efficiency

Applicability	All exhaust fan systems
Definition	The full-load efficiency of the motor serving the exhaust fan
Units	Unitless
Input Restrictions	As designed
Baseline Rules	From Table 10.8 of ASHRAE Standard 90.1-2007 or Table 10.2 of ASHRAE Standard 90.1-2001

Fan Part-Flow Power Curve

Applicability	All variable flow exhaust fan systems
Definition	A part-load power curve which represents the ratio full-load power draw of the exhaust fan as a function of the ratio full-load air flow.
Units	Unitless ratio
Input Restrictions	As designed. The default fan curve shall be selected from Equation (6.7.3-1) and Table 6.7.3-3 [8] for the type of fan specified in the proposed design.
Baseline Rules	The baseline building fan curve shall be selected from Equation (6.7.3-1) and Table 6.7.3-3 [8] for the type of fan specified in the proposed design.

Exhaust Fan KW

Applicability	All exhaust systems
Definition	The fan power of the exhaust fan per unit of flow. This building descriptor is applicable only with the power-per-unit-flow method.
Units	W/cfm
Input Restrictions	As designed.
Baseline Rules	The fan system power from Table 6.7.3-1 [6] or Table 6.7.3-2 [7]

6.7.4 Outdoor Air Controls and Economizers

Outside Air Controls

Maximum Outside Air Ratio

Applicability	All systems with modulating outside air dampers
Definition	The descriptor is used to limit the maximum amount of outside air that a system can provide as a percentage of the design supply air. It is used where the installation has a restricted intake capacity.
Units	Ratio
Input Restrictions	As designed
Baseline Rules	1.0

Design Outside Air Flow

Applicability	All systems with outside air dampers
Definition	The rate of outside air that needs to be delivered by the system at design conditions. This input may be derived from the sum of the design outside air flow for each of the zones served by the system.
Units	cfm
Input Restrictions	As designed
Baseline Rules	Same as proposed design. This input along with occupant density determines if the zones served by the system shall have demand control ventilation. See *ventilation control method* at the zone level.

Outdoor Air Control Method

Applicability	All HVAC systems that deliver outside air to zones
Definition	The method of determining the amount of outside air that needs to be delivered by the system. Each of the zones served by the system report their outside air requirements on an hourly basis. The options for determining the outside air at the zone level are discussed above. This control method addresses how the system responds to this information on an hourly basis. Options include:

Options include:

- Average Flow. The outside air delivered by the system is the sum of the outside air requirement for each zone, without taking into account the position of the VAV damper in each zone. The assumption is that there is mixing between zones through the return air fan.
- Critical Zone. The critical zone is the zone with the highest ratio of outside air to supply air. The assumption is that there is no mixing between zones. This method will provide greater outside air than the average flow method because when the critical zone sets the outside air fraction at the system, the other zones are getting greater outside air than required.

The quantity of outside air can be controlled in a number of ways, but a common method is to install a flow station at the outside air supply which modulates the position of the outside air and return dampers to maintain the desired outside air flow. With the average flow, a CO_2 sensor in the return air duct is another way to control the position of the outside air and return dampers.

Units List (see above)
Input Restrictions As designed
Baseline Rules Same as proposed design

Air Side Economizers

Economizer Control Type

Applicability All systems with an air-side economizer

Definition An air-side economizer increases outside air ventilation during periods when refrigeration loads can be reduced from increased outside air flow. The control types include:

- No economizer
- Fixed dry-bulb. The system shifts to 100% outside air and shuts off the cooling when the temperature of the outside air is equal to or lower than the supply air temperature.
- Differential dry-bulb. The system shifts to 100% outside air when the temperature of the outside air is lower than the return air temperature but continues to operate the cooling system until the outside air temperature reaches the supply air temperature.
- Fixed enthalpy. The system shifts to 100% outside air and shuts off the cooling when the enthalpy of the outside air is equal to or lower than the supply air enthalpy.
- Differential enthalpy. The system shifts to 100% outside air when the enthalpy of the outside air is lower than the return air enthalpy but continues to operate the cooling system until the outside air enthalpy reaches the supply air enthalpy.

Units List (see above)
Input Restrictions As designed
Baseline Rules The control should be *no economizer* when the baseline building cooling capacity _*TeX Embedding failed!*50 tons AND the baseline building system total cooling capacity *TeX Embedding failed!*95,000 Btu/h. Otherwise, the control should be based on the prescribed system type as shown in Table 6.7.4-1 [9].

Table 6.7.4-1: *"Baseline Economizer Control Type"*

Baseline building System	Economizer Control
System 1 – PTAC	None
System 2 – PTHP	None
System 3 – PSZ-AC	Differential dry-bulb None in climate zones 1a-4a and 1b
System 4 – PSZ-HP	Differential dry-bulb None in climate zones 1a-4a and 1b
System 5 – Packaged VAV with Reheat	Differential dry-bulb None in climate zones 1a-4a and 1b
System 6 – Packaged VAV with PFP boxes	Differential dry-bulb None in climate zones 1a-4a and 1b
System 7 – VAV with Reheat	Differential dry-bulb None in climate zones 1a-4a and 1b
System 8 – VAV with PFP boxes	Differential dry-bulb None in climate zones 1a-4a and 1b

Economizer High Temperature Lockout

Applicability Systems with fixed *dry-bulb* economizer
Definition The outside air setpoint temperature above which the economizer will return to minimum position.
Units Degrees Fahrenheit (°F)

Input Restrictions	As designed
Baseline Rules	Not applicable

Economizer Low Temperature Lockout

Applicability	Systems with air-side economizers
Definition	A feature that permits the lockout of economizer operation (return to minimum outside air position) when the outside air temperature is below the lockout setpoint.
Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed
Baseline Rules	Not used

Economizer High Enthalpy Lockout

Applicability	Systems with fixed enthalpy or differential enthalpy economizers
Definition	The outside air enthalpy above which the economizer will return to minimum position
Units	Btu/lb
Input Restrictions	As designed. The default is 25 Btu/lb.
Baseline Rules	No lockout limit

6.7.5 Cooling Systems

General

This group of building descriptors applies to all cooling systems.

Cooling Source

Applicability All systems

Definition The source of cooling for the system. The choices are:

- Chilled water
- Direct expansion (DX)
- Other

Units List (see above)

Input Restrictions As designed

Baseline Rules The baseline building cooling source is shown in Table 6.7.5-1 [10]. See Figure 6.1.2-1 [1] for HVAC system mapping.

Table 6.7.5-1: *"Cooling Source for Baseline Building System"*

Baseline building System	Cooling Source
System 1 – PTAC	Direct expansion (DX)
System 2 – PTHP	Direct expansion (DX)
System 3 – PSZ-AC	Direct expansion (DX)
System 4 – PSZ-HP	Direct expansion (DX)
System 5 – Packaged VAV with Reheat	Direct expansion (DX)
System 6 – Packaged VAV with PFP boxes	Direct expansion (DX)
System 7 – VAV with Reheat	Chilled water
System 8 – VAV with PFP boxes	Chilled water

Total Cooling Capacity

Applicability All cooling systems

Definition The total cooling capacity (both sensible and latent) of a cooling coil or packaged DX system at ARI conditions. The building descriptors defined in this chapter assume that the fan is modeled separately, including any heat it adds to the air stream. The cooling capacity specified by this building descriptor should not consider the heat of the fan.

Units kBtu/h

Input Restrictions

As designed. For packaged equipment that has the fan motor in the air stream such that it adds heat to the cooled air, the software shall adjust the *total cooling capacity* as follows:

(6.7.5-1)

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where

$\mathbf{Q}_{t,adj}$	The adjusted total cooling capacity of a packaged unit (kBtu/h)

$\mathbf{Q}_{t,rated}$	The ARI rated total cooling capacity of a packaged unit (kBtu/h) from manufactures' literature
$\mathbf{BHP}_{supply}$	The supply fan brake horsepower (bhp).

If the number of unmet load hours in the proposed design exceeds 300, the software shall warn the user to resize the equipment.

Baseline Rules The total cooling capacity of the baseline building is oversized by 15%. However, the cooling equipment may need to be subsequently downsized such that the difference in unmet load hours between the proposed design and the baseline building is less than 50 (see Chapter 2). Sizing calculations shall be based on 1% dry-bulb and 1% wet-bulb design conditions.

Sensible Cooling Capacity

Applicability All cooling systems

Definition The sensible heat cooling capacity of the coil or packaged equipment at ARI conditions. The building descriptors defined in this chapter assume that the fan is modeled separately, including any heat it adds to the air stream. The cooling capacity specified by this building descriptor should not consider the heat of the fan.

Units kBtu/h

Input Restrictions

As designed. For packaged equipment that has the fan motor located in the air stream such that it adds heat to the cooled air, the software shall adjust the *sensible cooling capacity* as follows:

(6.7.5-2)

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where

$\mathbf{Q}_{s,adj}$	The adjusted sensible cooling capacity of a packaged unit (kBtu/h)
$\mathbf{Q}_{s,rated}$	The ARI rated sensible cooling capacity of a packaged unit (kBtu/h)
$\mathbf{BHP}_{supply}$	The supply fan brake horsepower (bhp).

If the number of unmet load hours in the proposed design exceeds 300, the software shall warn the user to resize the equipment.

Baseline Rules The sensible cooling capacity of the baseline building is oversized by 15%. However, the cooling equipment may need to be subsequently downsized such that the difference in unmet load hours between the proposed design and the baseline building is less than 50 (see Chapter 2). Sizing calculations shall be based on 1% dry-bulb and 1% wet-bulb design conditions.

Cooling Capacity Adjustment Curves

Applicability All cooling systems

Definition

A curve that represents the available total cooling capacity as a function of cooling coil and/or condenser conditions. The common form of these curves is given as follows:

(6.7.5-3)

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For air cooled direct expansion

(6.7.5-4)

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For water cooled direct expansion

(6.7.5-5)

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For chilled water coils

(6.7.5-6)

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where

$\mathbf{Q}_{t,available}$	Available cooling capacity at specified evaporator and/or condenser conditions (MBH)

$\mathbf{Q_{t,adj}}$	Adjusted capacity at ARI conditions (Btu/h) (see Equation(6.7.5-1)
CAP_FT	A multiplier to adjust $Q_{t,adj}$
$\mathbf{t_{wb}}$	The entering coil wet-bulb temperature (°F)
$\mathbf{t_{db}}$	The entering coil dry-bulb temperature (°F)
$\mathbf{t_{wt}}$	The water supply temperature (°F)
$\mathbf{t_{odb}}$	The outside-air dry-bulb temperature (°F)

Note: if an air-cooled unit employs an evaporative condenser, t_{odb} is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.

Software may represent the relationship between cooling capacity and temperature in ways other than the equations given above.

Table 6.7.5-2: *"Cooling Capacity Curve Coefficients"*

Co-efficient	Air Cooled Direct Expansion		Water Cooled Direct Expansion		Chilled Water Coils	
	Air-Source (PTAC)	Air-Source (Other DX)	Water-Source (Heat Pump)	Water-Source (Other DX)	Fan-Coil	Other Chilled Water
a	1.1839345	0.8740302	-0.2780377	0.9452633	0.5038866	2.5882585
b	-0.0081087	-0.0011416	0.0248307	-0.0094199	-0.0869176	-0.2305879
c	0.0002110	0.0001711	-0.0000095	0.0002270	0.0016847	0.0038359
d	-0.0061435	-0.0029570	-0.0032731	0.0004805	0.0336304	0.1025812
e	0.0000016	0.0000102	0.0000070	-0.0000045	0.0002478	0.0005984
f	-0.0000030	-0.0000592	-0.0000272	-0.0000599	-0.0010297	-0.0028721
Note: These curves are the DOE-2.1E defaults, except for Water-Source (Other DX), which is taken from the "ECB Compliance Supplement, public review draft prepared by the SSPC 90.1 ECB Panel, Version 1.2, March 1996.						

Units Data structure

Input Restrictions As designed. The equations and coefficients given above are the default.

Baseline Rules Use the default curves or equivalent data for other models.

Coil Bypass Factor

Applicability All cooling systems

Definition The ratio of air that bypasses the cooling coil at design conditions to the total system airflow.

Units Ratio

Input Restrictions

As designed. Default values are given in Table 6.7.5-3 [11].

Table 6.7.5-3: *"Default Coil Bypass Factors"*

System Type	Default Bypass Factor
Packaged Terminal Air-conditioners and Heat Pumps	0.241
Other Packaged Equipment	0.190
Multi-Zone Systems	0.078
All Other	0.037

Baseline Rules Defaults

Coil Bypass Factor Adjustment Curve

Applicability All cooling systems

Definition Adjustments for the amount of coil bypass due to the following factors:

- Coil airflow rate as a percentage of rated system airflow
- Entering air wet-bulb temperature
- Entering air dry-bulb temperature
- Part load ratio

Units Data structure

Input Restrictions

Default to the simulation engine defaults based on HVAC system type. The following default values shall be used for the adjustment curves:

(6.7.5-7)

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(6.7.5-8)

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(6.7.5-9)

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(6.7.5-10)

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where

CBF_{rated}	The coil bypass factor at ARI rating conditions
CBF_{adj}	The coil bypass factor adjusted for airflow and coil conditions
CFMR	The ratio of airflow to design airflow
COIL-BF-FFLOW	A multiplier on the rated coil bypass factor to account for variation in air flow across the coil (take coefficients from Table 6.7.5-4 [12]
COIL-BF-FT	A multiplier on the rated coil bypass factor to account for a variation in coil entering conditions (take coefficients from Table 6.7.5-5 [13])
COIL-BF-FPLR	A multiplier on the rated coil bypass factor to account for the part load ratio (take coefficients from Table 6.7.5-6 [14])
T_{wb}	The entering coil wet-bulb temperature (°F)
T_{db}	The entering coil dry-bulb temperature (°F)
PLR	Part load ratio

And the coefficients are listed in the tables below.

Table 6.7.5-4: *"Coil Bypass Factor Airflow Adjustment Factor"*

Co-efficient	COIL-BF-FFLOW (PTAC)	COIL-BF-FFLOW (HP)	COIL-BF-FFLOW (PSZ/other)
a	-2.277	-0.8281602	-0.2542341
b	5.21140	14.3179150	1.2182558
c	-1.93440	-21.8894405	0.0359784
d		9.3996897	

Table 6.7.5-5: *"Coil Bypass Factor Temperature Adjustment Factor"*

Co-efficient	COIL-BF-FT (PTAC)	COIL-BF-FT (HP)	COIL-BF-FT (PSZ, other)
a	-1.5713691	-29.9391098	1.0660053
b	0.0469633	0.8753455	-0.0005170
c	0.0003125	-0.0057055	0.0000567
d	-0.0065347	0.1614450	-0.0129181
e	0.0001105	0.0002907	-0.0000017
f	-0.0003719	-0.0031523	0.0001503

Table 6.7.5-6: *"Coil Bypass Factor Part Load Adjustment Factor"*

Co-efficient	COIL-BF-FPLR (All Systems)
a	0.00
b	1.00

Baseline Rules Use defaults as described above.

Direct Expansion

Direct Expansion Cooling Efficiency

Applicability	Packaged equipment
Definition	The cooling efficiency of a direct expansion (DX) cooling system at ARI rated conditions as a ratio of output over input in Btu/h per W, excluding fan energy. The software must accommodate user input in terms of either the *Energy Efficiency Ratio* (EER) or the *Seasonal Energy Efficiency Ratio* (SEER). For equipment with SEER ratings, EER shall be taken from manufacturers' data when it is available. When it is not available it shall be calculated as follows: (6.7.5-11) *TeX Embedding failed!* For all unitary and applied equipment where the fan energy is part of the equipment efficiency rating, the EER shall be adjusted as follows: (6.7.5-12) *TeX Embedding failed!* where **EER_{adj}** The adjusted Energy Efficiency Ratio for simulation purposes **EER** The rated Energy Efficiency Ratio **$Q_{t,rated}$** The ARI rated total cooling capacity of a packaged unit (kBtu/h) **BHP_{supply}** The supply fan brake horsepower (bhp) shall be taken from manufacturers' literature when available, otherwise use Equation(6.7.3-2).
Units	Btu/h-W
Input Restrictions	As designed. When possible, specify the SEER and EER for packaged equipment with cooling capacity less than 65,000 Btu/h. For equipment with capacity above 65,000 Btu/h, specify EER.
Baseline Rules	For the purpose of green building ratings, look up the requirement from Table 6.8.1A and Table 6.8.1B in ASHRAE Standard 90.1-2007. For the purpose of tax deduction calculations, look up the requirement from Table 6.2.1A and 6.2.1B in ASHRAE Standard 90.1-2001. Use the total cooling capacity of the proposed design to determine the size category.

Direct Expansion Cooling Efficiency Adjustment Curve

Applicability	Packaged DX equipment
Definition	A curve or group of curves that varies the cooling efficiency of a direct expansion (DX) coil as a function of evaporator conditions, condenser conditions and part-load ratio. The default curves are given as follows as adjustments to the energy input ratio (EIR)[1]: (6.7.5-13) *TeX Embedding failed!* (6.7.5-14) *TeX Embedding failed!* (6.7.5-15) For air-cooled DX systems: *TeX Embedding failed!* (6.7.5-16) For water-cooled DX systems: *TeX Embedding failed!* (6.7.5-17) *TeX Embedding failed!* where **PLR** Part load ratio based on available capacity (not rated capacity) **EIR-FPLR** A multiplier on the EIR to account for the part load ratio **EIR-FT** A multiplier on the EIR to account for the wet-bulb temperature entering the coil and the outdoor dry-bulb

EIR-FT A multiplier on the EIR to account for the wet-bulb temperature entering the coil and the outdoor dry-bulb temperature

$Q_{operating}$ Present load on heat pump (Btu/h)

$Q_{available}$ Heat pump available capacity at present evaporator and condenser conditions (in Btu/h).

t_{wb} The entering coil wet-bulb temperature (°F)

t_{wt} The water supply temperature (°F)

t_{odb} The outside-air dry-bulb temperature (°F)

P_{rated} Rated power draw at ARI conditions (kW)

$P_{operating}$ Power draw at specified operating conditions (kW)

Note: if an air-cooled unit employs an evaporative condenser, t_{odb} is the effective dry-bulb temperature of the air leaving the evaporative cooling unit.

Table 6.7.5-7: *"Cooling System Coefficients for EIR-FPLR"*

Co-efficient	Water-Source (Heat Pump)	Water-Source (Other)	Air-Source (PTAC)	Air-Source (Other)
a	0.1250000	0.2012301	0.1250000	0.2012301
b	0.8750000	-0.0312175	0.8750000	-0.0312175
c	0.0000000	1.9504979	0.0000000	1.9504979
d	0.0000000	-1.1205105	0.0000000	-1.1205105

Table 6.7.5-8: *"Cooling System Coefficients for EIR-FT"*

Co-efficient	Water-Source (Heat Pump)	Water-Source (Other)	Air-Source (PTAC)	Air-Source (Other)
a	2.0280385	-1.8394760	-0.6550461	-1.0639310
b	-0.0423091	0.0751363	0.0388910	0.0306584
c	0.0003054	-0.0005686	-0.0001925	-0.0001269
d	0.0149672	0.0047090	0.0013046	0.0154213
e	0.0000244	0.0000901	0.0001352	0.0000497
f	-0.0001640	-0.0001218	-0.0002247	-0.0002096

Units Data structure

Input Restrictions User may input curves or use default curves. If defaults are overridden, the software must indicate that supporting documentation is required on the output forms.

Baseline Rules Use default curves.

Minimum Unloading Ratio

Applicability Packaged systems which use hot-gas bypass during low load conditions

Definition The upper end of the hot-gas bypass operating range. This is the percentage of peak cooling capacity below which hot-gas bypass will operate.

Units Ratio

Input Restrictions As designed. The user must enter this descriptor for each DX cooling system. If hot-gas bypass is not employed, a value of 0 may be entered. A maximum of 0.5 is allowed for units with a peak cooling capacity of 240 kBtu/h (20 tons) or less, and a maximum value of 0.25 is allowed for units with a peak cooling capacity greater than 240 kBtu/h.

Baseline Rules Not applicable

Minimum HGB Ratio

Applicability Packaged systems which use hot-gas bypass during low load conditions

Definition The lower end of the hot-gas bypass operating range. The percentage of peak cooling capacity below which hot-gas bypass will no longer operate (i.e. the compressor will cycle).

Units Ratio

Input Restrictions As designed. The user must enter this descriptor for each DX cooling system. If hot-gas bypass is not employed, a value of 0 may be entered.

Baseline Rules Not applicable

Condenser Type

Applicability All direct expansion systems including heat pumps

Definition The type of condenser for a direct expansion (DX) cooling system. The choices are:

- Air-Cooled
- Water-Cooled
- Air-Cooled with Evaporative Pre-cooler

Units List (see above)

Input Restrictions As designed

Baseline Rules Based on the prescribed system type. Refer to the HVAC System Map in Figure 6.1.2-1 [1].

Table 6.7.5-9: *"Baseline Building Condenser Type"*

Baseline building System	Condenser Type
System 1 – PTAC	Air-cooled
System 2 – PTHP	Air-cooled
System 3 – PSZ-AC	Air-cooled
System 4 – PSZ-HP	Air-Cooled
System 5 – Packaged VAV with Reheat	Air-cooled
System 6 – Packaged VAV with PFP boxes	Air-cooled
System 7 – VAV with Reheat	N/A
System 8 – VAV with PFP boxes	N/A

Condenser Flow Type

Applicability All direct expansion systems including heat pumps

Definition Describes water flow control for a water-cooled condenser. The choices are:

- Fixed Flow
- Two-position
- Variable Flow

Units List (see above)

Input Restrictions Default to fixed flow. If the variable-flow is selected, the software must indicate that supporting documentation is required on the output forms.

Baseline Rules Always fixed flow

Evaporative Cooler

This is equipment that pre-cools the outside air that is brought into the building. It may be used with any type of cooling system that brings in outside air. This equipment is not applicable for the baseline building.

Evaporative Cooling Type

Applicability Systems with evaporative pre-cooling

Definition

The type of evaporative pre-cooler, including:

- None
- Non-Integrated Indirect
- Non-Integrated Direct/Indirect
- Integrated Indirect
- Integrated Direct/Indirect

An integrated pre-cooler can operate together with the compression or CHW cooling. A non-integrated pre-cooler will shut down the evaporative cooling whenever it is unable to provide 100% of the cooling required.

In all cases, the evaporative pre-cooler must be modeled with 100% of the outside air routed through the pre-cooler.

Units None

Input Restrictions As designed

Baseline Rules Not applicable

Direct Stage Effectiveness

Applicability Systems with evaporative pre-cooling

Definition

The effectiveness of the direct stage of an evaporative cooling system. Effectiveness is defined as follows:

(6.7.5-18)

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where

DirectEFF The direct stage effectiveness

$\mathbf{T}_{db}$	The entering air dry-bulb temperature
$\mathbf{T}_{wb}$	The entering air wet-bulb temperature
$\mathbf{T}_{direct}$	The direct stage leaving dry-bulb temperature

Units Numeric

Input Restrictions As designed

Baseline Rules Not applicable

Indirect Stage Effectiveness

Applicability Systems with evaporative pre-cooling

Definition

The effectiveness of the indirect stage of an evaporative cooling system. Effectiveness is defined as follows:

(6.7.5-19)

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where

IndEFF	The indirect stage effectiveness
$\mathbf{T}_{db}$	The entering air dry-bulb temperature of the supply air
$\mathbf{T}_{wb}$	The entering air wet-bulb temperature of the “scavenger air”
$\mathbf{T}_{ind}$	The supply air leaving dry-bulb temperature

Units Numeric

Input Restrictions As designed

Baseline Rules Not applicable

Evaporative Cooling Performance Curves

Applicability Systems with evaporative cooling

Definition

A curve that varies the evaporative cooling effectiveness as a function of primary air stream airflow. The default curves are given as follows:

(6.7.5-20)

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where

PLR	Part load ratio of airflow based on design airflow
EFF-FFLOW	A multiplier on the evaporative cooler effectiveness to account for variations in part load
$\mathbf{CFM}_{operating}$	Operating primary air stream airflow (cfm)
$\mathbf{CFM}_{design}$	Design primary air stream airflow (cfm)

Table 6.7.5-10: *"Part Load Curve Coefficients – Evaporative Cooler Effectiveness"*

Co-efficient	Direct	Indirect
a	1.1833000	1.0970000
b	-0.2575300	-0.1650600
c	0.0742450	0.0680690

Units Data structure

Input Restrictions User may input curves or use default curves. If defaults are overridden, the software must indicate that supporting documentation is required on the output forms.

Baseline Rules Not used.

Auxiliary Evaporative Cooling Power

Applicability Systems with evaporative cooling

Definition The auxiliary energy of the indirect evaporative cooler fan, and the pumps for both direct and indirect stages

Units kW/cfm

Input Restrictions As designed

Baseline Rules Not applicable

Evaporative Cooling Scavenger Air Source

Applicability Systems with evaporative cooling

Definition The source of scavenger air for an indirect section of an evaporative cooler. Options include:

- Return Air
- Outside Air

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Not applicable

Evaporative Condenser

Evaporative Condenser Power	
Applicability	Direct expansion systems with an evaporatively cooled condenser
Definition	The power of the evaporative precooling unit. This includes any pump(s) and/or fans that are part of the precooling unit.
Units	Kilowatts (kW)
Input Restrictions	As designed
Baseline Rules	Not applicable

Evaporative Condenser Effectiveness	
Applicability	Direct expansion systems with an evaporatively cooled condenser
Definition	The effectiveness of the evaporative precooling unit for a condenser. Effectiveness is defined as follows:

(6.7.5-21)

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where

DirectEFF	The direct stage effectiveness
$\mathbf{T}_{db}$	The entering air dry-bulb temperature
$\mathbf{T}_{wb}$	The entering air wet-bulb temperature
$\mathbf{T}_{direct}$	The direct stage leaving dry-bulb temperature

Units	Ratio
Input Restrictions	As designed
Baseline Rules	Not applicable

Evaporative Condenser Operation Range	
Applicability	Direct expansion systems with an evaporatively cooled condenser.
Definition	The temperature range within which the evaporative condenser operates. Two values are provided:

$T_{maximum}$ The threshold outside air dry-bulb temperature below which evaporative condenser operates.

$T_{minimum}$ The threshold outside air dry-bulb temperature above which evaporative condenser operates.

Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed
Baseline Rules	Not applicable

1. The EIR is the ratio of energy used by the system to cooling capacity in the same units. It is the reciprocal of the coefficient of performance (COP).

6.7.6 Heating Systems

General

Heating Source	
Applicability	All systems that provide heating
Definition	The source of heating for the heating and preheat coils. The choices are:

- Hot water
- Steam
- Electric resistance
- Electric heat pump
- Gas furnace

- Gas heat pump (optional feature)
- Oil furnace
- Heat recovery (for preheat coils in proposed designs)

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Based on the prescribed system type. Refer to the HVAC System Map in Figure 6.1.2-1 [1].

Table 6.7.6-1: *"Heating Source for Baseline Building"*

Baseline Building System	Heating Source
System 1 – PTAC	Gas Furnace
System 2 – PTHP	Heat pump
System 3 – PSZ-AC	Gas or Oil Furnace
System 4 – PSZ-HP	Heat pump
System 5 – Packaged VAV with Reheat	Hot water
System 6 – Packaged VAV with PFP boxes	Electric Resistance
System 7 – VAV with Reheat	Hot water
System 8 – VAV with PFP boxes	Electric Resistance

Preheat Coil

Preheat Coil Capacity

Applicability	Systems with a preheat coil located in the outside air stream
Definition	The heating capacity of a preheating coil at design conditions.
Units	Btu/h
Input Restrictions	As designed
Baseline Rules	If the proposed design has a preheat coil and it can be modeled in the baseline building system, then the baseline building also has a preheat coil sized to meet the preheat coil temperature specified for the proposed design. Autosize to maintain the preheat coil temperature of the proposed design.

Heating Coils

Systems with boilers have heating coils, including baseline building systems 1, 5 and 7.

Heating Coil Capacity

Applicability	All systems with a heating coil
Definition	The heating capacity of a heating coil at ARI conditions
Units	Btu/h
Input Restrictions	As designed. Adjust the capacity if the number of unmet load hours exceeds 300.
Baseline Rules	Autosize with a heating oversizing factor of 25%. If the number of unmet load hours for the proposed design exceeds the number of unmet load hours for the baseline building by more than 50, reduce the heating coil capacity as indicated in Figure 2.5.2-1 [3].

Furnace

Furnace Capacity

Applicability	Systems with a furnace
Definition	The full load heating capacity of the unit
Units	Btu/h
Input Restrictions	As designed. Adjust the capacity if the number of unmet load hours exceeds 300.
Baseline Rules	Autosize with an oversizing factor of 25% (let the software determine heating capacity based on the building loads). If the number of unmet load hours for the proposed design exceeds the number of unmet load hours for the baseline building by more than 50, reduce the furnace capacity as indicated in Figure 2.4-1 [2] and Figure 2.5.2-1 [3].

Furnace Fuel Heating Efficiency

Applicability	Systems with a furnace
Definition	The full load thermal efficiency of either a gas or oil furnace at design conditions. The software must accommodate input in either *Thermal Efficiency* (E_t) or *Annual Fuel Utilization Efficiency* (AFUE). Where AFUE is provided, E_t shall be calculated as follows:

(6.7.6-1)

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where

AFUE	The annual fuel utilization efficiency (%)
$\mathbf{E_t}$	The thermal efficiency (fraction)

Units Fraction

Input Restrictions As designed

Baseline Rules Look up the requirement from the equipment efficiency tables in Table 6.8.1E of Standard 90.1-2007 Table 6.2.1E of Standard 90.1-2001. Use the heating input of the proposed design system to determine the size category.

Furnace Fuel Heating Part Load Efficiency Curve

Applicability Systems with furnaces

Definition An adjustment factor that represents the percentage of full load fuel consumption as a function of the percentage full load capacity. This curve shall take the form of a quadratic equation as follows:

(6.7.6-2)

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(6.7.6-3)

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where

FHeatPLC	The Fuel Heating Part Load Efficiency Curve
$\mathbf{Fuel}_{partload}$	The fuel consumption at part load conditions (Btu/h)
$\mathbf{Fuel}_{rated}$	The fuel consumption at full load (Btu/h)
$\mathbf{Q}_{partload}$	The capacity at part load conditions (Btu/h)
$\mathbf{Q}_{rated}$	The capacity at rated conditions (Btu/h)

Table 6.7.6-2: *"Furnace Efficiency Curve Coefficients"*

Coefficient	Furnace
a	0.0186100
b	1.0942090
c	-0.1128190

Units Data structure

Input Restrictions As designed when data is available, otherwise use the default values are provided above.

Baseline Rules Use defaults

Furnace Fuel Heating Pilot

Applicability Systems that use a furnace for heating

Definition The fuel input for a pilot light on a furnace

Units Btu/h

Input Restrictions As designed

Baseline Rules Zero (pilotless ignition)

Furnace Fuel Heating Fan/Auxiliary

Applicability Systems that use a furnace for heating

Definition The fan energy in forced draft furnaces and the auxiliary (pumps and outdoor fan) energy in fuel-fired heat pumps

Units Kilowatts (kW)

Input Restrictions As designed

Baseline Rules Not applicable

Electric Heat Pump

Electric Heat Pump Heating Capacity

Applicability All heat pumps

Definition	The full load heating capacity of the unit, excluding supplemental heating capacity at ARI rated conditions
Units	Btu/h
Input Restrictions	As designed
Baseline Rules	Autosize and use an oversizing factor of 25% (let the software determine heating capacity based on the building loads). The autosized equipment may need to be downsized to achieve a maximum difference in unmet load hours between the proposed design and the baseline building of 50.

Electric Heat Pump Supplemental Heating Source

Applicability All heat pumps

Definition The auxiliary heating source for a heat pump heating system. The common control sequence is to lock out the heat pump compressor when the supplemental heat is activated. Other building descriptors may be needed if this is not the case. Choices for supplemental heat include:

- Electric resistance
- Gas furnace
- Oil furnace
- Hot water
- Other

Units List (see above)

Input Restrictions As designed

Baseline Rules Electric resistance

Electric Heat Pump Heating Efficiency

Applicability All heat pumps

Definition

The heating efficiency of a heat pump at ARI rated conditions as a dimensionless ratio of output over input. The software must accommodate user input in terms of either the *Coefficient of Performance* (COP) or the *Heating Season Performance Factor* (HSPF). Where HSPF is provided, COP shall be calculated as follows:

(6.7.6-4)

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For all unitary and applied equipment where the fan energy is part of the equipment efficiency rating, the COP shall be adjusted as follows to remove the fan energy:

(6.7.6-5)

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where

COP_{adj}	The adjusted coefficient of performance for simulation purposes
COP	The ARI rated coefficient of performance
$HCAP_{rated}$	The ARI rated heating capacity of a packaged unit (kBtu/h)
BHP_{supply}	The supply fan brake horsepower (bhp).

Refer to building descriptor *Supply Fan BHP*.

Units Unitless

Input Restrictions As designed

Baseline Rules For the purpose of green building ratings, look up the requirement from the equipment efficiency Table 6.8.1B and Table 6.8.1D in ASHRAE Standard 90.1-2007. For the purpose of tax deduction calculations, find the equipment efficiency from Table 6.2.1B and 6.2.1D in ASHRAE Standard 90.1-2001. Use the heating capacity of the proposed design to determine the size category.

Electric Heat Pump Heating Capacity Adjustment Curve(s)

Applicability All heat pumps

Definition

A curve or group of curves that represent the available heat-pump heating capacity as a function of evaporator and condenser conditions. The default curves are given as follows:

(6.7.6-6)

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For air-cooled heat pumps:

(6.7.6-7)

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For water-cooled heat pumps:

(6.7.6-8)

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where

$Q_{available}$	Available heating capacity at present evaporator and condenser conditions (kBtu/h)
t_{db}	The entering coil dry-bulb temperature (°F)
t_{wt}	The water supply temperature (°F)
t_{odb}	The outside-air dry-bulb temperature (°F)
Q_{rated}	Rated capacity at ARI conditions (in kBtu/h

Table 6.7.6-3: *"Heat Pump Capacity Adjustment Curves (CAP-FT)"*

Coefficient	Water-Source	Air-Source
a	0.4886534	0.2536714
b	-0.0067774	0.0104351
c	N/A	0.0001861
d	0.0140823	-0.0000015

Units Data structure

Input Restrictions User may input curves or use default curves. If defaults are overridden, supporting documentation shall be provided.

Baseline Rules Use default curves.

Electric Heat Pump Heating Efficiency Adjustment Curve(s)

Applicability All heat pumps

Definition

A curve or group of curves that varies the heat-pump heating efficiency as a function of evaporator conditions, condenser conditions and part-load ratio. The default curves are given as follows:

(6.7.6-9)

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(6.7.6-10)

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Air Source Heat Pumps:

(6.7.6-11)

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Water Source Heat Pumps:

(6.7.6-12)

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(6.7.6-13)

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where

PLR	Part load ratio based on available capacity (not rated capacity)
EIR-FPLR	A multiplier on the EIR of the heat pump as a function of part load ratio
EIR-FT	A multiplier on the EIR of the heat pump as a function of the wet-bulb temperature entering the coil and the outdoor dry-bulb temperature
Q	Present load on heat pump (Btu/h)

$\mathbf{Q}_{operating}$ Present load on heat pump (Btu/h)

$\mathbf{Q}_{available}$ Heat pump available capacity at present evaporator and condenser conditions (Btu/h).

$\mathbf{t}_{db}$ The entering coil dry-bulb temperature (°F)

$\mathbf{t}_{wt}$ The water supply temperature (°F)

$\mathbf{t}_{odb}$ The outside air dry-bulb temperature (°F)

$\mathbf{P}_{rated}$ Rated power draw at ARI conditions (kW)

$\mathbf{P}_{operating}$ Power draw at specified operating conditions (kW)

Table 6.7.6-4: *"Heat Pump Heating Efficiency Adjustment (Curves)"*

Coefficient	Air-and Water-Source EIR-FPLR	Water-Source EIR-FT	Air-Source EIR-FT
a	0.0856522	1.3876102	2.4600298
b	0.9388137	0.0060479	-0.0622539
c	-0.1834361	N/A	0.0008800
d	0.1589702	-0.0115852	-0.0000046

Units None

Input Restrictions User may input curves or use default curves. If defaults are overridden, documentation shall be provided.

Baseline Rules Use default curves

Electric Heat Pump Supplemental Heating Capacity

Applicability All heat pumps

Definition The design heating capacity of a heat pump supplemental heating coil at ARI conditions

Units Btu/h

Input Restrictions As designed

Baseline Rules Autosize

Electric Supplemental Heating Control Temp

Applicability All heat pumps

Definition The outside dry-bulb temperature below which the heat pump supplemental heating is allowed to operate

Units Degrees Fahrenheit (°F)

Input Restrictions As designed. Default to 40°F

Baseline Rules 40°F

Coil Defrost

Applicability Air-cooled electric heat pump

Definition The defrost control mechanism for an air-cooled heat pump. The choices are:

- Hot-gas defrost, on-demand
- Hot-gas defrost, timed 3.5 minute cycle
- Electric resistance defrost, on-demand
- Electric resistance defrost, timed 3.5 minute cycle

Defrost shall be enabled whenever the outside air dry-bulb temperature drops below 40°F.

Units List (see above)

Input Restrictions Default to use hot-gas defrost, timed 3.5 minute cycle. User may select any of the above.

Baseline Rules The baseline building uses the default.

Coil Defrost kW

Applicability Heat pumps with electric resistance defrost

Definition The capacity of the electric resistance defrost heater

Units Kilowatts (kW)

Input Restrictions As designed. This descriptor defaults to 0 if nothing is entered.

Baseline Rules Not applicable. Baseline building systems 2 and 4 use hot-gas, timed 3.5 minute cycle.

Crank Case Heater kW

Applicability All heat pumps

Definition The capacity of the electric resistance heater in the crank case of a direct expansion (DX) compressor. The crank case heater operates only when the compressor is off.

Units Kilowatts (kW)

Input Restrictions As designed. This descriptor defaults to 0 if nothing is entered.

Baseline Rules Zero (0)

Crank Case Heater Shutoff Temperature

Applicability All heat pumps

Definition The outdoor air dry-bulb temperature above which the crank case heater is not permitted to operate.

Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed. This descriptor defaults to 50°F.
Baseline Rules	50°F

Heat Recovery

Exhaust to Outside Heat Recovery Effectiveness

Applicability Any system with outside air heat recovery

Definition

The effectiveness of an air-to-air heat exchanger between the building exhaust and entering outside air streams. Effectiveness is defined as follows:

(6.7.6-14)

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where

HREFF	The air-to-air heat exchanger effectiveness
$\mathbf{EEA}_{db}$	The exhaust air dry-bulb temperature entering the heat exchanger
$\mathbf{ELA}_{db}$	The exhaust air dry-bulb temperature leaving the heat exchanger
$\mathbf{OSA}_{db}$	The outside air dry-bulb temperature

Units	Ratio
Input Restrictions	As designed
Baseline Rules	Required for fan systems with a design supply air flow rate of 5,000 cfm or greater if the minimum outside air quantity is 70% of the design air flow rate. If required, the energy recovery system should have at least 50% effectiveness. Energy recovery is not required for heating systems in climate zones 1 through 3 or for cooling systems in climate zones 3c, 4c, 5b, 5c, 6b, 7 and 8.

Condenser Heat Recovery Effectiveness

Applicability	Systems that use recover heat from a condenser
Definition	The percentage of heat rejection at design conditions from a DX or heat pump unit in cooling mode that is available for space or water heating.
Units	Percent (%)
Input Restrictions	As designed. The software must indicate that supporting documentation is required on the output forms if heat recovery is specified.
Baseline Rules	Not applicable for most conditions. Condenser heat recovery is required for 24-hour facilities when the heat rejection exceeds 6,000,000 Btu/h and the design service water heating load exceeds 1,000,000 Btu/h. When required, the effectiveness will be 60%.

Heat Recovery Use

Applicability Systems that use heat recovery

Definition The end use of the heat recovered from a DX or heat pump unit. The choices are:

- Reheat coils
- Water heating

Units	List (see above)
Input Restrictions	As designed. The software must indicate that supporting documentation is required on the output forms if heat recovery is specified.
Baseline Rules	Not applicable for most conditions. The end use will be water heating if required for 24-hour facility operation.

6.7.7 Humidity Controls and Devices

General

Humidifier Type

Applicability Optional humidifier

Definition The type of humidifier employed. Choices include:

- Hot-Water
- Steam
- Electric
- Evaporative Humidification

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Same as the proposed design

Humidistat Maximum Setting

Applicability	Systems with humidity control
Definition	The control setpoint for dehumidification
Units	Percent (%)
Input Restrictions	As designed
Baseline Rules	Same as the proposed design

Humidistat Minimum Setting

Applicability	Systems with humidity control
Definition	The control setpoint for humidification
Units	Percent (%)
Input Restrictions	As designed
Baseline Rules	Same as proposed design

Desiccant

Desiccant Type

Applicability Systems with desiccant dehumidification

Definition Describes the configuration of desiccant cooling equipment
The following configurations for desiccant systems are allowed:

- LIQ-VENT-AIR1 – a liquid desiccant dehumidifying unit
- LIQ-VENT-AIR2 – a liquid desiccant dehumidifying unit combined with a gas-fired absorption chiller
- SOL-VENT-AIR1 – a solid desiccant dehumidifying unit
- NO-DESICCANT – the default, which indicates that no desiccant system is present

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Not applicable

Desiccant Control Mode

Applicability Systems with desiccant dehumidification

Definition The method of controlling the operation of the desiccant unit. For liquid-based systems this can be either:

- Dry-bulb – the desiccant unit is turned on whenever the outside air dry-bulb exceeds a set limit.
- Evaporative cooling– cycles the desiccant unit on when an evaporative cooler is on to maintain a dewpoint setpoint.
- Dewpoint – cycles the desiccant unit on and off to maintain the dewpoint temperature of the supply air.

For solid-based systems the following configurations are possible:

- Dehumidification only – the desiccant unit cycles on and off to maintain indoor humidity levels
- Sensible heat exchanger plus regeneration – the desiccant unit includes a sensible heat exchanger to precool the hot, dry air leaving the desiccant unit. The air leaving the exhaust side of the heat exchanger is directed to the desiccant unit
- Sensible heat exchanger – the desiccant unit includes a heat exchanger, but the air leaving the exhaust side of the heat exchanger is exhausted to the outdoors

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Not applicable

Desiccant Air Fraction

Applicability	Systems with desiccant dehumidification
Definition	The fraction of the supply air that passes through the desiccant unit. Typically either the minimum outside air fraction or all of the air passes through the desiccant system.
Units	Ratio
Input Restrictions	As designed
Baseline Rules	Not applicable

Desiccant Heat Source

Applicability Systems with desiccant dehumidification

Definition The source of heat that is used to dry out the desiccant. This can be either:

- Gas – Hydronic – the regeneration heat load is met with a gas-fired heater

- Hot water – the heat load is met with hot water from the plant

Units	List (see above)
Input Restrictions	As designed
Baseline Rules	Not applicable

Liquid Desiccant Performance Curves

Applicability Systems with liquid-based desiccant dehumidification

Definition

A set of performance curves that apply to liquid desiccant systems.

(6.7.7-1)

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(6.7.7-2)

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(6.7.7-3)

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(6.7.7-4)

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where

DESC-T-FTW	temperature leaving desiccant unit
DESC-W-FTW	humidity ratio leaving desiccant unit
DESC-Gas-FTW	Gas usage of desiccant unit
DESC-kW-FTW	Electric usage of desiccant unit
T	entering air temperature
w	entering humidity ratio

Table 6.7.7-1: *"Liquid Desiccant Unit Performance Curves"*

Coefficient	DESC-T-FTW	DESC-W-FTW	DESC-Gas-FTW	DESC-kW-FTW
a	11.5334997	11.8993998	58745.8007813	3.5179000
b	0.6586730	-0.2695580	-1134.4899902	-0.0059317
c	-0.0010280	0.0044549	-3.6676099	0.0000000
d	0.2950410	0.0830525	3874.5900879	0.0040401
e	-0.0001700	0.0006974	-1.6962700	0.0000000
f	-0.0008724	0.0015879	-13.0732002	0.0000000

Units	Data structure
Input Restrictions	As designed, default to values in Table 6.7.7-1 [15]
Baseline Rules	Not applicable

Desiccant Dewpoint Temperature Setpoint

Applicability	Systems with desiccant dehumidification
Definition	The setpoint dewpoint temperature of the air leaving the desiccant system
Units	Degrees Fahrenheit (°F)
Input Restrictions	As designed. Defaults to 50°F.
Baseline Rules	Not applicable

Desiccant Heat Exchanger Effectiveness

Applicability	Systems with desiccant dehumidification
Definition	The effectiveness of a sensible heat exchanger used with a desiccant system
Units	Ratio
Input Restrictions	As designed
Baseline Rules	Not applicable

Desiccant Heat Exchanger Pressure Drop

Applicability	Systems with desiccant dehumidification
Definition	The pressure drop across a sensible heat exchanger used with a desiccant system
Units	in. H2O
Input Restrictions	As designed. Defaults to 1.0 in. H_2O

Input Restrictions As designed. Defaults to 1.0 in. H_2O

Baseline Rules Not applicable

Source URL: http://www.comnet.org/mgp/content/67-hvac-secondary-systems

Links:
[1] http://www.comnet.org/mgp/content/hvac-system-map#hvac-mapping
[2] http://www.comnet.org/mgp/content/24-calculation-procedures#calculation-process-for-tax-deductions-and-green-building-ratings
[3] http://www.comnet.org/mgp/content/252-sizing-equipment-baseline-building#procedure-for-adjusting-equipment-hvac-sizes-in-the-baseline-building
[4] http://www.comnet.org/mgp/content/system-controls#sat-cooling-setpoint-reset-based-on-outdoor-air-temperature-oat-for-dry-b-and-marine-c-climates
[5] http://www.comnet.org/mgp/content/system-controls#example-of-sat-heating-setpoint-reset-based-on-outdoor-air-temperature-oat
[6] http://www.comnet.org/mgp/content/673-fan-systems#baseline-building-fan-system-—-ASHRAE-standard-90.1-2007
[7] http://www.comnet.org/mgp/content/673-fan-systems#baseline-building-fan-system-—-ASHRAE-standard-90.1-2001
[8] http://www.comnet.org/mgp/content/673-fan-systems#fan-curve-default-values
[9] http://www.comnet.org/mgp/content/674-outdoor-air-controls-and-economizers#baseline-economizer-control-type
[10] http://www.comnet.org/mgp/content/675-cooling-systems#cooling-source-for-baseline-building-system
[11] http://www.comnet.org/mgp/content/675-cooling-systems#default-coil-bypass-factors
[12] http://www.comnet.org/mgp/content/675-cooling-systems#coil-bypass-factor-airflow-adjustment-factor
[13] http://www.comnet.org/mgp/content/675-cooling-systems#coil-bypass-factor-temperature-adjustment-factor
[14] http://www.comnet.org/mgp/content/675-cooling-systems#coil-bypass-factor-part-load-adjustment-actor
[15] http://www.comnet.org/mgp/content/677-humidity-controls-and-devices#liquid-desiccant-unit-performance-curves