Input Output Reference

The Encyclopedic Reference to EnergyPlus Input and Output

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## Group – Heating and Cooling Coils

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### Coil:Cooling:DX:SingleSpeed

This DX cooling coil model and input are quite different from that for the heating and cooling water coils. The simple water coils use an NTU-effectiveness heat exchanger model. The single speed DX coil model uses performance information at rated conditions along with curve fits for variations in total capacity, energy input ratio and part-load fraction to determine performance at part-load conditions. Sensible/latent capacity splits are determined by the rated sensible heat ratio (SHR) and the apparatus dewpoint/bypass factor (ADP/BF) approach. This approach is analogous to the NTU-effectiveness calculations used for sensible-only heat exchanger calculations, extended to a cooling and dehumidifying coil.

This DX cooling coil input requires an availability schedule, the rated total cooling capacity, the rated SHR, the rated COP, and the rated air volume flow rate. The latter 4 inputs determine the coil performance at the rating point (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb and air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb). The rated air volume flow rate should be between .00004027 m3/s and .00006041 m3/s per watt of rated total cooling capacity (300 to 450 cfm/ton).

The rated volumetric air flow to total cooling capacity ratio for 100% dedicated outdoor air (DOAS) application DX cooling coils should be between 0.00001677 (m3/s)/W (125 cfm/ton) and 0.00003355 (m3/s)/W (250 cfm/ton).

This model requires 5 curves as follows:

1. The total cooling capacity modifier curve (function of temperature) is a biquadratic curve with two independent variables: wet-bulb temperature of the air entering the cooling coil, and dry-bulb temperature of the air entering the air-cooled condenser coil (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated total cooling capacity to give the total cooling capacity at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures).
2. The total cooling capacity modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total cooling capacity and the total cooling capacity modifier curve (function of temperature) to give the total cooling capacity at the specific temperature and air flow conditions at which the coil is operating.
3. The energy input ratio (EIR) modifier curve (function of temperature) is a biquadratic curve with two independent variables: wet-bulb temperature of the air entering the cooling coil, and dry-bulb temperature of the air entering the air-cooled condenser coil (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated EIR (inverse of the rated COP) to give the EIR at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures).
4. The energy input ratio (EIR) modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated EIR (inverse of the rated COP) and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the coil is operating.
5. The part load fraction correlation (function of part load ratio) is a quadratic or cubic curve with the independent variable being part load ratio (sensible cooling load / steady-state sensible cooling capacity). The output of this curve is used in combination with the rated EIR and EIR modifier curves to give the “effective” EIR for a given simulation timestep. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling. The curve should be normalized to a value of 1.0 when the part-load ratio equals 1.0 (i.e., the compressor(s) run continuously for the simulation timestep).

The curves are simply specified by name. Curve inputs are described in the curve manager section of this document (see Performance Curves in this document).

The next four input fields are optional and relate to the degradation of latent cooling capacity when the supply air fan operates continuously while the cooling coil/compressor cycle on and off to meet the cooling load. The fan operating mode is determined in the partent object and is considered to either be constant (e.g. CoilSystem:Cooling:DX) or can be scheduled (e.g. AirLoopHVAC:UnitaryHeatCool). When scheduled, the schedule value must be greater than 0 to calculate degradation of latent cooling capacity. At times when the parent object’s supply air fan operating mode schedule is 0, latent degradation will be ignored. When modeling latent capacity degradation, these next four input fields must all have positive values.

The next input specifies the outdoor air node used to define the conditions of the air entering the outdoor condenser. If this field is left blank, the outdoor temperature entering the condenser is taken directly from the weather data. If this field is not blank, the node name specified must be listed in an OutdoorAir:Node object where the height of the node is taken into consideration when calculating outdoor temperature from the weather data. Alternately, the node name must be specified in an OutdoorAir:NodeList object where the outdoor temperature entering the condenser is taken directly from the weather data.

The next input describes the type of outdoor condenser coil used with the DX cooling coil (Air Cooled or Evap Cooled). The following three inputs are required when modeling an evaporative-cooled condenser: evaporative condenser effectiveness, evaporative condenser air volume flow rate, and the power consumed by the evaporative condenser pump. Crankcase heater capacity and cutout temperature are entered in the next two input fields. These two fields for this object define the name of the water storage tank for supply and condensate collection. See section “DX Cooling Coil Model” in the EnergyPlus Engineering Document for further details regarding this model.

The last two input fields following the Basin Heater Operating Schedule Name are the Sensible Heat Ratio (SHR) modifier cruve names for temperature and flow fraction. These two input fields are optional and used only when a user intends to override SHR calculated using the apparatus dew point (ADP) and bypass factor (BF) method. See section “SHR Calculation Using User Specified SHR Modifier Curves” in the EnergyPlus Engineering Document for further details.

#### Field: Name

A unique user-assigned name for an instance of a DX cooling coil. Any reference to this DX coil by another object will use this name.

#### Field: Availability Schedule Name

The name of the schedule (ref: Schedule) that denotes whether the DX cooling coil can run during a given time period. A schedule value greater than 0 (usually 1 is used) indicates that the unit can be on during a given time period. A value less than or equal to 0 (usually 0 is used) denotes that the unit must be off. If this field is blank, the schedule has values of 1 for all time periods.

#### Field: Rated Total Cooling Capacity

The total, full load cooling capacity (sensible plus latent) in watts of the DX coil unit at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb[[1]](#footnote-1), and a cooling coil air flow rate defined by field “rated air volume flow rate” below). Capacity should be “gross” (i.e., supply air fan heat is NOT included). When used in a heat pump, the rated total cooling capacity should be within 20% of the rated total heating capacity, otherwise a warning message is issued.

#### Field: Rated Sensible Heat Ratio

The sensible heat ratio (SHR=sensible capacity divided by total cooling capacity) of the DX cooling coil at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate” below). Both the sensible and total cooling capacities used to define the Rated SHR should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Rated COP

The coefficient of performance (cooling power output in watts divided by electrical power input in watts) of the DX cooling coil unit at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/ 23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate” below). The input power includes electric power for the compressor(s) and condenser fan(s) but does not include the power consumption of the supply air fan. The cooling power output is the value entered above in the field “Rated Total Cooling Capacity (gross)”. If this input field is left blank, the default value is 3.0.

#### Field: Rated Air Flow Rate

The air volume flow rate, in m3 per second, across the DX cooling coil at rated conditions. The rated air volume flow rate should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total cooling capacity (300 to 450 cfm/ton). For DOAS applications the rated air volume flow rate should be between 0.00001677 m3/s and 0.00003355 m3/s per watt of rated total cooling capacity (125 to 250 cfm/ton). The rated total cooling capacity, rated SHR and rated COP should be performance information for the unit with air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and the rated air volume flow rate defined here.

#### Field: Rated Evaporator Fan Power Per Volume Flow Rate

This field is the electric power for the evaporator (cooling coil) fan per air volume flow rate through the coil at the rated conditions in W/(m3/s). The default value is 773.3 W/(m3/s) (365 W/1000 cfm) if this field is left blank. If a value is entered, it must be >= 0.0 and <= 1250 W/(m3/s). This value is only used to calculate Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER), Integrated Energy Efficiency Ratio (IEER) and the Standard Rating (Net) Cooling Capacity which will be outputs in the EnergyPlus eio file (ref. EnergyPlus Engineering Reference, Single Speed DX Cooling Coil, Standard Ratings). This value is not used for modeling the evaporator (cooling coil) fan during simulations; instead, it is used for calculating SEER, EER, IEER and Standard Rating Cooling Capacity to assist the user in verifying their inputs for modeling this type of equipment.

#### Field: Air Inlet Node Name

The name of the HVAC system node from which the DX cooling coil draws its inlet air.

#### Field: Air Outlet Node Name

The name of the HVAC system node to which the DX cooling coil sends its outlet air.

#### Field: Total Cooling Capacity Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the total cooling capacity as a function of the wet-bulb temperature of the air entering the cooling coil, and the dry-bulb temperature of the air entering the air-cooled condenser coil (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated total cooling capacity to give the total cooling capacity at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Total Cooling Capacity Function of Flow Fraction Curve Name

The name of a quadratic or cubic performance curve (ref: Performance Curves) that parameterizes the variation of total cooling capacity as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total cooling capacity and the total cooling capacity modifier curve (function of temperature) to give the total cooling capacity at the specific temperature and air flow conditions at which the coil is operating. The curve is normalized to have the value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Energy Input Ratio Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the wet-bulb temperature of the air entering the cooling coil, and the dry-bulb temperature of the air entering the air-cooled condenser coil (wet-bulb temperature if modeling an evaporative-cooled condenser). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR (inverse of rated COP) to give the EIR at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to a value of 1.0 at the rating point.

#### Field: Energy Input Ratio Function of Flow Fraction Curve Name

The name of a quadratic or cubic performance curve (Ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Part Load Fraction Correlation Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (Ref: Performance Curves) that parameterizes the variation of electrical power input to the DX unit as a function of the part load ratio (PLR, sensible cooling load/steady-state sensible cooling capacity). The product of the rated EIR and EIR modifier curves is divided by the output of this curve to give the “effective” EIR for a given simulation timestep. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling.

The part load fraction correlation should be normalized to a value of 1.0 when the part load ratio equals 1.0 (i.e., no efficiency losses when the compressor(s) run continuously for the simulation timestep). For PLR values between 0 and 1 (0 <= PLR < 1), the following rules apply:

PLF >= 0.7 and PLF >= PLR

If PLF < 0.7 a warning message is issued, the program resets the PLF value to 0.7, and the simulation proceeds. The runtime fraction of the coil is defined as PLR/PLF. If PLF < PLR, then a warning message is issued and the runtime fraction of the coil is limited to 1.0.

A typical part load fraction correlation for a conventional, single-speed DX cooling coil (e.g., residential unit) would be:

PLF = 0.85 + 0.15(PLR)

If the user wishes to model no efficiency degradation due to compressor cycling, the part load fraction correlation should be defined as follows:

PLF = 1.0 + 0.0(PLR)

#### Field: Nominal Time for Condensate Removal to Begin

The nominal time (in seconds) after startup for condensate to begin leaving the coil's condensate drain line at the coil's rated airflow and temperature conditions, starting with a dry coil. Nominal time is equal to the ratio of the energy of the coil's maximum condensate holding capacity (J) to the coil's steady-state latent capacity (W). Suggested value is 1000; zero value means the latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]), and this field as well as the next three input fields for this object must have positive values in order to model latent capacity degradation.

#### Field: Ratio of Initial Moisture Evaporation Rate and Steady State Latent Capacity

Ratio of the initial moisture evaporation rate from the cooling coil (when the compressor first turns off, in Watts) and the coil's steady-state latent capacity (Watts) at rated airflow and temperature conditions. Suggested value is 1.5; zero value means the latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]); and this field, the previous field and the next two fields must have positive values in order to model latent capacity degradation.

#### Field: Maximum Cycling Rate

The maximum on-off cycling rate for the compressor (cycles per hour), which occurs at 50% run time fraction. Suggested value is 3; zero value means latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]); and this field, the previous two fields and the next field must have positive values in order to model latent capacity degradation.

#### Field: Latent Capacity Time Constant

Time constant (in seconds) for the cooling coil's latent capacity to reach steady state after startup. Suggested value is 45: supply air fan operating mode must be continuous. That is, the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects (e.g., AirloopHVAC:UnitaryHeatCool), and this field as well as the previous three input fields for this object must have positive values in order to model latent capacity degradation.

#### Field: Condenser Air Inlet Node Name

This optional alpha field specifies the outdoor air node name used to define the conditions of the air entering the outdoor condenser. If this field is left blank, the outdoor air temperature entering the condenser (dry-bulb or wet-bulb) is taken directly from the weather data. If this field is not blank, the node name specified must also be specified in an OutdoorAir:Node object where the height of the node is taken into consideration when calculating outdoor air temperature from the weather data. Alternately, the node name may be specified in an OutdoorAir:NodeList object where the outdoor air temperature is taken directly from the weather data.

#### Field: Condenser Type

The type of condenser used by the DX cooling coil. Valid choices for this input field are **AirCooled** or **EvaporativelyCooled**. The default for this field is **AirCooled**.

#### Field: Evaporative Condenser Effectiveness

The effectiveness of the evaporative condenser, which is used to determine the temperature of the air entering the outdoor condenser coil as follows:



where

*Tcond inlet* = the temperature of the air entering the condenser coil (C)

*Twb,o*= the wet-bulb temperature of the outdoor air (C)

*Tdb,o*= the dry-bulb temperature of the outdoor air (C)

The resulting condenser inlet air temperature is used by the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature). The default value for this field is 0.9, although valid entries can range from 0.0 to 1.0. This field is not used when Condenser Type = Air Cooled.

If the user wants to model an air-cooled condenser, they should simply specify AirCooled in the field Condenser Type. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature.

If the user wishes to model an evaporative-cooled condenser AND they have performance curves that are a function of the wet-bulb temperature of air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled and the evaporative condenser effectiveness value should be entered as 1.0. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of the wet-bulb temperature of air entering the condenser coil.

If the user wishes to model an air-cooled condenser that has evaporative media placed in front of it to cool the air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled. The user must also enter the appropriate evaporative effectiveness for the media. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature. Be aware that the evaporative media will significantly reduce the dry-bulb temperature of the air entering the condenser coil, so the Total Cooling Capacity and EIR Modifier Curves must be valid for the expected range of dry-bulb temperatures that will be entering the condenser coil.

#### Field: Evaporative Condenser Air Flow Rate

The air volume flow rate, in m3 per second, entering the evaporative condenser. This value is used to calculate the amount of water used to evaporatively cool the condenser inlet air. The minimum value for this field must be greater than zero, and this input field is autosizable (equivalent to 0.000144 m3/s per watt of rated total cooling capacity [850 cfm/ton]). This field is not used when Condenser Type = Air Cooled.

#### Field: Evaporative Condenser Pump Rated Power Consumption

The rated power of the evaporative condenser water pump in Watts. This value is used to calculate the power required to pump the water used to evaporatively cool the condenser inlet air. The default value for this input field is zero, but it is autosizable (equivalent to 0.004266 W per watt [15 W/ton] of rated total cooling capacity). This field is not used when Condenser Type = Air Cooled.

#### Field: Crankcase Heater Capacity

This numeric field defines the crankcase heater capacity in Watts. When the outdoor air dry-bulb temperature is below the value specified in the input field “Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation” (described below), the crankcase heater is enabled during the time that the compressor is not running. If this cooling coil is used as part of an air-to-air heat pump (Ref. AirLoopHVAC:UnitaryHeatPump:AirToAir or PackageTerminal: HeatPump:AirToAir), the crankcase heater defined for this DX cooling coil is ignored and the crankcase heater power defined for the DX heating coil (Ref. Coil:Heating:DX:SingleSpeed) is enabled during the time that the compressor is not running for either heating or cooling. The value for this input field must be greater than or equal to 0, and the default value is 0. To simulate a DX cooling coil without a crankcase heater, enter a value of 0.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation

This numeric field defines the outdoor air dry-bulb temperature above which the compressor’s crankcase heater is disabled. The value for this input field must be greater than or equal to 0.0°C, and the default value is 10°C.

#### Field: Supply Water Storage Tank Name

This field is optional. It is used to describe where the coil obtains water used for evaporative cooling of its condenser. If blank or omitted, then the unit will obtain water directly from the mains. If the name of a Water Storage Tank object is used here, then the unit will obtain its water from that tank. If a tank is specified, the unit will attempt to obtain all the water it uses from the tank. However if the tank cannot provide all the water the condenser needs, then the unit will still operate and obtain the rest of the water it needs from the mains (referred to as StarvedWater).

#### Field: Condensate Collection Water Storage Tank Name

This field is optional. It is used to describe where condensate from the coil is collected. If blank or omitted, then any coil condensate is discarded. Enter the name of Water Storage Tank object defined elsewhere and the condensate will then be collected in that tank.

#### Field: Basin Heater Capacity

This numeric field contains the capacity of the DX coil’s electric evaporative cooler basin heater in watts per degree Kelvin. This field only applies for Condenser Type = EvaporativelyCooled. This field is used in conjunction with the Basin Heater Setpoint Temperature described in the following field. The basin heater electric power is equal to this field multiplied by the difference between the basin heater set point temperature and the outdoor dry-bulb temperature. The basin heater only operates when the DX coil is off, regardless of the basin heater schedule described below. The basin heater capacity must be greater than or equal to zero, with a default value of zero if this field is left blank.

#### Field: Basin Heater Setpoint Temperature

This numeric field contains the set point temperature (˚C) for the basin heater described in the previous field. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater is active when the outdoor air dry-bulb temperature falls below this setpoint temperature, as long as the DX coil is off. This set point temperature must be greater than or equal to 2˚C, and the default value is 2˚C if this field is left blank.

#### Field: Basin Heater Operating Schedule Name

This alpha field contains the name of the basin heater operating schedule. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater operating schedule is assumed to be an on/off schedule and the heater is available to operate any time the schedule value is greater than 0. The basin heater operates when scheduled on and the outdoor air dry-bulb temperature is below the set point temperature described in the previous field. If this field is left blank, the basin heater is available to operate throughout the simulation. Regardless of this schedule, the basin heater may only operate when the DX coil is off.

#### Field: Sensible Heat Ratio Function of Temperature Curve Name

The name of a biquadratic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of DX cooling coil entering air wet-bulb and dry-bulb temperatures. The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of flow fraction) to give the SHR at the specific coil entering air temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 at the rated condition. This input field is optional.

#### Field: Sensible Heat Ratio Function of Flow Fraction Curve Name

The name of a quadratic or cubic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of temperature) to give the SHR at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate. This input field is optional.

#### Field: Zone Name for Condenser Placement

This input field is name of a conditioned or unconditioned zone where the secondary coil (condenser) of DX system or a heat pump is to be placed. This is an optional input field specified only when user desires to reject the condenser heat into a zone. The heat rejected is modeled as sensible internal gain of a secondary zone.

Following is an example input for a Coil:Cooling:DX:SingleSpeed coil.

Coil:Cooling:DX:SingleSpeed,

Zone1WindACDXCoil, ! Coil Name

FanAndCoilAvailSched, ! Availability Schedule

10548, ! Rated Total Cooling Capacity (gross)

0.75, ! Rated SHR

3.0, ! Rated COP

0.637, ! Rated Air Volume Flow Rate (m3/s)

773.3, ! Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

Zone1WindACFanOutletNode, ! Coil Air Inlet Node

Zone1WindACAirOutletNode, ! Coil Air Outlet Node

WindACCoolCapFT, ! Total Cooling Capacity Modifier Curve (function of temperature)

WindACCoolCapFFF, ! Total Cooling Capacity Modifier Curve (function of flow fraction)

WindACEIRFT, ! Energy Input Ratio Modifier Curve (function of temperature)

WindACEIRFFF, ! Energy Input Ratio Modifier Curve (function of flow fraction)

WindACPLFFPLR, ! Part Load Fraction Correlation (function of part load ratio)

1000., ! Nominal Time for Condensate Removal to Begin {s}

1.5, ! Ratio of Initial Moisture Evaporation Rate and Steady-state Latent Capacity

3.0, ! Maximum ON/OFF Cycling Rate {cycles/hr}

45.0, ! Latent Capacity Time Constant {s}

, ! Condenser Air Inlet Node Name

AirCooled, ! Condenser Type

, ! Evaporative Condenser Effectiveness

, ! Evaporative Condenser Air Volume Flow Rate {m3/s}

, ! Evaporative Condenser Pump Rated Power Consumption {W}

30., ! Crankcase Heater Capacity {W}

10.; ! Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation {C}

### Coil:Cooling:DX:TwoSpeed

This component models a two-speed (or variable speed) DX compressor and fan. The method is based on the model used for the cycling, single speed DX unit. The single speed unit is described by single full load capacity, SHR, COP, and air flow rate at rated conditions. Off rated full load performance is obtained by the use of 4 modifier curves. At partial load the unit cycles on/off and the cycling losses are described by a part load fraction curve.

The multispeed unit is described by specifying the performance at two states: high speed compressor, high speed fan; and low speed compressor, low speed fan. When the unit load is above the high speed capacity, the unit runs with high speed compressor and fan. When the load on the unit is below the high speed capacity but above the low speed capacity, the unit will run with performance intermediate between high speed and low speed. When the load is less than the low speed capacity, the unit will cycle on/off just like the single speed unit.

The multispeed unit model requires 2 full sets of performance data. There must be a high and low speed capacity, SHR, COP, and evaporator air flow rate; as well as high and low speed performance curves – total cooling capacity modifier curve (function of temperature) and energy input ratio modifier curve (function of temperature).

The multispeed DX component should be used for all cases in which a DX VAV system is being simulated. Obviously this model – in which performance is obtained by interpolating between 2 specified states - is an oversimplification of how real multi-speed and variable speed DX cooling units are controlled. But detailed descriptions of how actual units perform and are controlled are not available. This model should give a good average prediction of multispeed and variable speed DX cooling unit performance. The last four input fields following the Basin Heater Operating Schedule Name are the Sensible Heat Ratio (SHR) modifier cruve names for temperature and flow fraction for high and low speed DX cooling coils. These four input fields are optional and used only when a user intends to override SHR calculated using the apparatus dew point (ADP) and bypass factor (BF) method. See section “SHR Calculation Using User Specified SHR Modifier Curves” in the EnergyPlus Engineering Document for further details..

#### Field: Name

A unique user-assigned name for an instance of a multispeed DX cooling coil. Any reference to this DX coil by another object will use this name.

#### Field: Availability Schedule Name

The name of the schedule (ref: Schedule) that denotes whether the DX cooling coil can run during a given time period. A schedule value greater than 0 (usually 1 is used) indicates that the unit can be on during the time period. A value less than or equal to 0 (usually 0 is used) denotes that the unit must be off for the time period. If this field is blank, the schedule has values of 1 for all time periods.

#### Field: Rated High Speed Total Cooling Capacity

The total, full load cooling capacity (sensible plus latent) in watts of the DX coil unit for high speed compressor and high speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate” below). Capacity should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Rated High Speed Sensible Heat Ratio

The sensible heat ratio (sensible capacity divided by total cooling capacity) of the DX cooling coil for high speed compressor and high speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb[[2]](#footnote-2), and a cooling coil air flow rate defined by field “rated air volume flow rate” below). Both the sensible and total cooling capacities used to define the Rated SHR should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Rated High Speed COP

The coefficient of performance (cooling power output in watts divided by electrical power input in watts) of the DX cooling coil unit for high speed compressor and high speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate” below)The input power includes electric power for the compressor(s) and condenser fan(s) but does not include the power consumption of the supply air fan. The cooling power output is the value entered above in the field “Rated Total Cooling Capacity (gross)”. If this input field is left blank, the default value is 3.0.

#### Field: Rated High Speed Air Flow Rate

The high speed air volume flow rate, in m3 per second, across the DX cooling coil at rated conditions. The rated air volume flow rate should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total cooling capacity. For DOAS applications the rated air volume flow rate should be between 0.00001677 m3/s and 0.00003355 m3/s per watt of rated total cooling capacity (125 to 250 cfm/ton). The rated total cooling capacity, rated SHR and rated COP should be performance information for the unit with air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and the rated air volume flow rate defined here.

#### Field: Unit Internal Static Air Pressure

If this coil is used with a Fan:VariableVolume to model a packaged variable-air-volume unit, then ratings for standard rated net capacity, EER, and IEER will be calculated per ANSI/AHRI Standard 340/360-2007 with Addenda 1 and 2. This field is to specify the internal static air pressure, in units of Pascals, associated with the unit’s supply air flow for rating purposes. This field does not affect the performance during operation. This field is optional. If this field is used, then the internal static air pressure is used with the associated fan characteristics when calculating standard rated net capacity, EER, and IEER. If this field is not used, then the standard ratings are still performed but use a default for specific fan power of 773.3 (W/(m3/s)). The air pressure drop/rise input here should be “internal” in the sense that it is for the entire package of unitary equipment as it would be tested in a laboratory (including other non-cooling sections inside the package for filters, dampers, and.or heating coils) but none of the “external” pressure drop for distributing supply air throughout the building. This is different from the input field called Pressure Rise in the fan object which includes both the external static pressure and the internal static pressure. The results of standard rating calculations are reported to the EIO file and to predefined output tables called “DX Cooling Coils” and “VAV DX Cooling Standard Rating Details.”

#### Field: Air Inlet Node

The name of the HVAC system node from which the DX cooling coil draws its inlet air.

#### Field: Air Outlet Node

The name of the HVAC system node to which the DX cooling coil sends its outlet air.

#### Field: Total Cooling Capacity Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the total cooling capacity as a function of the wet-bulb temperature of the air entering the cooling coil, and the dry-bulb temperature of the air entering the air-cooled condenser (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated total cooling capacity to give the total cooling capacity at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to have the value of 1.0 at the rating point. This curve is used for performance at the high speed compressor, high speed fan operating point.

#### Field: Total Cooling Capacity Function of Flow Fraction Curve Name

The name of a quadratic performance curve (ref: Performance Curves) that parameterizes the variation of total cooling capacity as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total cooling capacity and the total cooling capacity modifier curve (function of temperature) to give the total cooling capacity at the specific temperature and air flow conditions at which the coil is operating. The curve is normalized to have the value of 1.0 when the actual air flow rate equals the rated air flow rate. This curve is applied only at the high speed compressor, high speed fan operating point. There is no corresponding curve for the low speed operating point.

#### Field: Energy Input Ratio Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the wet-bulb temperature of the air entering the cooling coil and the dry-bulb temperature of the air entering the air-cooled condenser (wet-bulb temperature if modeling an evaporative-cooled condenser). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR (inverse of rated COP) to give the EIR at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to a value of 1.0 at the rating point. This curve is used for performance at the high speed compressor, high speed fan operating point.

#### Field: Energy Input Ratio Function of Flow Fraction Curve Name

The name of a quadratic performance curve (Ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate. This curve is applied only at the high speed compressor, high speed fan operating point. There is no corresponding curve for the low speed operating point.

#### Field: Part Load Fraction Correlation Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (Ref: Performance Curves) that parameterizes the variation of electrical power input to the DX unit as a function of the part load ratio (PLR, sensible cooling load/steady-state sensible cooling capacity). The product of the rated EIR and EIR modifier curves is divided by the output of this curve to give the “effective” EIR for a given simulation timestep. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling.

The part load fraction correlation should be normalized to a value of 1.0 when the part load ratio equals 1.0 (i.e., no efficiency losses when the compressor(s) run continuously for the simulation timestep). For PLR values between 0 and 1 (0 <= PLR < 1), the following rules apply:

PLF >= 0.7 and PLF >= PLR

If PLF < 0.7 a warning message is issued, the program resets the PLF value to 0.7, and the simulation proceeds. The runtime fraction of the coil is defined as PLR/PLF. If PLF < PLR, then a warning message is issued and the runtime fraction of the coil is limited to 1.0.

A typical part load fraction correlation for a conventional, single-speed DX cooling coil (e.g., residential unit) would be:

PLF = 0.85 + 0.15(PLR)

If the user wishes to model no efficiency degradation due to compressor cycling, the part load fraction correlation should be defined as follows:

PLF = 1.0 + 0.0(PLR)

#### Field: Rated Low Speed Total Cooling Capacity

The total, full load cooling capacity (sensible plus latent) in watts of the DX coil unit for low speed compressor and low speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate, low speed” below). Capacity should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Rated Low Speed Sensible Heat Ratio

The sensible heat ratio (SHR=sensible capacity divided by total cooling capacity) of the DX cooling coil for low speed compressor and low speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate, low speed” below). Both the sensible and total cooling capacities used to define the Rated SHR should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Rated Low Speed COP

The coefficient of performance (COP=cooling power output in watts divided by electrical power input in watts) of the DX cooling coil unit for low speed compressor and low speed fan at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “rated air volume flow rate, low speed” below). The input power includes power for the compressor(s) and condenser fan(s) but does not include the power consumption of the supply air fan. The cooling power output is the value entered above in the field “Rated Total Cooling Capacity (gross)”. If this input field is left blank, the default value is 3.0.

#### Field: Rated Low Speed Air Flow Rate

The low speed volume air flow rate, in m3 per second, across the DX cooling coil at rated conditions. The rated air volume flow rate should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total cooling capacity. For DOAS applications the rated air volume flow rate should be between 0.00001677 m3/s and 0.00003355 m3/s per watt of rated total cooling capacity (125 to 250 cfm/ton). The rated total cooling capacity, rated SHR and rated COP should be performance information for the unit with air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and the rated air volume flow rate defined here.

#### Field: Low Speed Total Cooling Capacity Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the total cooling capacity as a function of the wet-bulb temperature of the air entering the cooling coil, and the dry-bulb temperature of the air entering the air-cooled condenser (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated total cooling capacity to give the total cooling capacity at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to have the value of 1.0 at the rating point. This curve is used for performance at the low speed compressor, low speed fan operating point.

#### Field: Low Speed Energy Input Ratio Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the wetbulb temperature of the air entering the cooling coil and the drybulb temperature of the air entering the air-cooled condenser (wetbulb temperature if modeling an evaporative-cooled condenser). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR (inverse of rated COP) to give the EIR at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to a value of 1.0 at the rating point. This curve is used for performance at the low speed compressor, low speed fan operating point.

#### Field: Condenser Air Inlet Node Name

This optional alpha field specifies the outdoor air node name used to define the conditions of the air entering the outdoor condenser. If this field is left blank, the outdoor air temperature entering the condenser (dry-bulb or wet-bulb) is taken directly from the weather data. If this field is not blank, the node name specified must also be specified in an OutdoorAir:Node object where the height of the node is taken into consideration when calculating outdoor air temperature from the weather data. Alternately, the node name may be specified in an OutdoorAir:NodeList object where the outdoor air temperature is taken directly from the weather data.

#### Field: Condenser Type

The type of condenser used by the multi-speed DX cooling coil. Valid choices for this input field are **AirCooled** or **EvaporativelyCooled**. The default for this field is **AirCooled**.

#### Field: High Speed Evaporative Condenser Effectiveness

The effectiveness of the evaporative condenser at high compressor/fan speed, which is used to determine the temperature of the air entering the outdoor condenser coil as follows:



where

*Tcond inlet* = the temperature of the air entering the condenser coil (C)

*Twb,o*= the wet-bulb temperature of the outdoor air (C)

*Tdb,o*= the dry-bulb temperature of the outdoor air (C)

The resulting condenser inlet air temperature is used by the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature). The default value for this field is 0.9, although valid entries can range from 0.0 to 1.0. This field is not used when Condenser Type = Air Cooled.

If the user wants to model an air-cooled condenser, they should simply specify AirCooled in the field Condenser Type. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature.

If the user wishes to model an evaporative-cooled condenser AND they have performance curves that are a function of the wet-bulb temperature of air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled and the evaporative condenser effectiveness value should be entered as 1.0. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of the wet-bulb temperature of air entering the condenser coil.

If the user wishes to model an air-cooled condenser that has evaporative media placed in front of it to cool the air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled. The user must also enter the appropriate evaporative effectiveness for the media. In this case, the Total Cooling Capacity Modifier Curve (function of temperature) and the Energy Input Ratio Modifier Curve (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature. Be aware that the evaporative media will significantly reduce the dry-bulb temperature of the air entering the condenser coil, so the Total Cooling Capacity and EIR Modifier Curves must be valid for the expected range of dry-bulb temperatures that will be entering the condenser coil.

#### Field: High Speed Evaporative Condenser Air Flow Rate

The air volume flow rate, in m3 per second, entering the evaporative condenser at high compressor/fan speed. This value is used to calculate the amount of water used to evaporatively cool the condenser inlet air. The minimum value for this field must be greater than zero, and this input field is autosizable (equivalent to 0.000144 m3/s per watt of rated high-speed total cooling capacity [850 cfm/ton]). This field is not used when Condenser Type = Air Cooled.

#### Field: High Speed Evaporative Condenser Pump Rated Power Consumption

The rated power of the evaporative condenser water pump in Watts at high compressor/fan speed. This value is used to calculate the power required to pump the water used to evaporatively cool the condenser inlet air. The default value for this input field is zero, but it is autosizable (equivalent to 0.004266 W per watt [15 W/ton] of rated high-speed total cooling capacity). This field is not used when Condenser Type = Air Cooled.

#### Field: Low Speed Evaporative Condenser Effectiveness

The effectiveness of the evaporative condenser at low compressor/fan speed, which is used to determine the temperature of the air entering the outdoor condenser coil as follows:



where

*Tcond inlet* = the temperature of the air entering the condenser coil (C)

*Twb,o*= the wet-bulb temperature of the outdoor air (C)

*Tdb,o*= the dry-bulb temperature of the outdoor air (C)

The resulting condenser inlet air temperature is used by the Total Cooling Capacity Modifier Curve, low speed (function of temperature) and the Energy Input Ratio Modifier Curve, low speed (function of temperature). The default value for this field is 0.9, although valid entries can range from 0.0 to 1.0. This field is not used when Condenser Type = Air Cooled. See field “Evaporative Condenser Effectiveness, High Speed” above for further information.

#### Field: Low Speed Evaporative Condenser Air Flow Rate

The air volume flow rate, in m3 per second, entering the evaporative condenser at low compressor/fan speed. This value is used to calculate the amount of water used to evaporatively cool the condenser inlet air. The minimum value for this field must be greater than zero, and this input field is autosizable (equivalent to 0.000048 m3/s per watt of rated high-speed total cooling capacity [280 cfm/ton]). This field is not used when Condenser Type = Air Cooled.

#### Field: Low Speed Evaporative Condenser Pump Rated Power Consumption

The rated power of the evaporative condenser water pump in Watts at low compressor/fan speed. This value is used to calculate the power required to pump the water used to evaporatively cool the condenser inlet air. The default value for this input field is zero, but it is autosizable (equivalent to 0.001422 W per watt [5 W/ton] of rated high-speed total capacity). This field is not used when Condenser Type = Air Cooled.

#### Field: Supply Water Storage Tank Name

This field is optional. It is used to describe where the coil obtains water used for evaporative cooling. If blank or omitted, then the cooler will obtain water directly from the mains. If the name of a Water Storage Tank object is used here, then the cooler will obtain its water from that tank. If a tank is specified, the coil will attempt to obtain all the water it uses from the tank. However if the tank cannot provide all the water the cooler needs, then the cooler will still operate and obtain the rest of the water it needs from the mains (referred to as StarvedWater).

#### Field: Condensate Collection Water Storage Tank Name

This field is optional. It is used to describe where condensate from the coil is collected. If blank or omitted, then any coil condensate is discarded. Enter the name of Water Storage Tank object defined elsewhere and the condensate will then be collected in that tank.

#### Field: Basin Heater Capacity

This numeric field contains the capacity of the DX coil’s electric evaporative cooler basin heater in watts per degree Kelvin. This field only applies for Condenser Type = EvaporativelyCooled. This field is used in conjunction with the Basin Heater Setpoint Temperature described in the following field. The basin heater electric power is equal to this field multiplied by the difference between the basin heater set point temperature and the outdoor dry-bulb temperature. The basin heater only operates when the DX coil is off, regardless of the basin heater schedule described below. The basin heater capacity must be greater than or equal to zero, with a default value of zero if this field is left blank.

#### Field: Basin Heater Setpoint Temperature

This numeric field contains the set point temperature (˚C) for the basin heater described in the previous field. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater is active when the outdoor air dry-bulb temperature falls below this setpoint temperature, as long as the DX coil is off. This set point temperature must be greater than or equal to 2˚C, and the default value is 2˚C if this field is left blank.

#### Field: Basin Heater Operating Schedule Name

This alpha field contains the name of the basin heater operating schedule. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater operating schedule is assumed to be an on/off schedule and the heater is available to operate any time the schedule value is greater than 0. The basin heater operates when scheduled on and the outdoor air dry-bulb temperature is below the set point temperature described in the previous field. If this field is left blank, the basin heater is available to operate throughout the simulation. Regardless of this schedule, the basin heater may only operate when the DX coil is off.

Following is an example input for the object.

Coil:Cooling:DX:TwoSpeed,

Main Cooling Coil 1, !- Name

CoolingCoilAvailSched, !- Availability Schedule Name

autosize, !- Rated High Speed Total Cooling Capacity {W}

0.68, !- Rated High Speed Sensible Heat Ratio

3.0, !- Rated High Speed COP

autosize, !- Rated High Speed Air Flow Rate {m3/s}

, !- Unit Internal Static Air Pressure Drop {Pa}

Mixed Air Node 1, !- Air Inlet Node Name

Main Cooling Coil 1 Outlet Node, !- Air Outlet Node Name

VarSpeedCoolCapFT, !- Total Cooling Capacity Function of Temperature Curve Name

PackagedRatedCoolCapFFlow, !- Total Cooling Capacity Function of Flow Fraction Curve Name

VarSpeedCoolEIRFT, !- Energy Input Ratio Function of Temperature Curve Name

PackagedRatedCoolEIRFFlow, !- Energy Input Ratio Function of Flow Fraction Curve Name

VarSpeedCyclingPLFFPLR, !- Part Load Fraction Correlation Curve Name

autosize, !- Rated Low Speed Total Cooling Capacity {W}

0.69, !- Rated Low Speed Sensible Heat Ratio

4.2, !- Rated Low Speed COP

autosize, !- Rated Low Speed Air Flow Rate {m3/s}

VarSpeedCoolCapLSFT, !- Low Speed Total Cooling Capacity Function of Temperature Curve Name

VarSpeedCoolEIRLSFT, !- Low Speed Energy Input Ratio Function of Temperature Curve Name

Main Cooling Coil 1 Condenser Node; !- Condenser Air Inlet Node Name

#### Field: Sensible Heat Ratio Function of Temperature Curve Name

The name of a biquadratic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of DX cooling coil entering air wet-bulb and dry-bulb temperatures. The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of flow fraction) to give the SHR at the specific coil entering air temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 at the rated condition. This input field is optional.

#### Field: Sensible Heat Ratio Function of Flow Fraction Curve Name

The name of a quadratic or cubic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of temperature) to give the SHR at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate. This input field is optional.

#### Field: Low Sensible Heat Ratio Function of Temperature Curve Name

The name of a biquadratic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of DX cooling coil entering air wet-bulb and dry-bulb temperatures. The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of flow fraction) to give the SHR at the specific coil entering air temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 at the rated condition. This input field is optional.

#### Field: Low Sensible Heat Ratio Function of Flow Fraction Curve Name

The name of a quadratic or cubic normalized curve (Ref: Performance Curves) that parameterizes the variation of the sensible heat ratio (SHR) as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated SHR and the SHR modifier curve (function of temperature) to give the SHR at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate. This input field is optional.

#### Field: Zone Name for Condenser Placement

This input field is name of a conditioned or unconditioned zone where the secondary coil (condenser) of DX system or a heat pump is to be placed. This is an optional input field specified only when user desires to reject the condenser heat into a zone. The heat rejected is modeled as sensible internal gain of a secondary zone.

Following is an example input for the object.

Coil:Cooling:DX:TwoSpeed,

Main Cooling Coil 1, !- Name

CoolingCoilAvailSched, !- Availability Schedule Name

autosize, !- Rated High Speed Total Cooling Capacity {W}

0.68, !- Rated High Speed Sensible Heat Ratio

3.0, !- Rated High Speed COP

autosize, !- Rated High Speed Air Flow Rate {m3/s}

, !- Unit Internal Static Air Pressure Drop {Pa}

Mixed Air Node 1, !- Air Inlet Node Name

Main Cooling Coil 1 Outlet Node, !- Air Outlet Node Name

VarSpeedCoolCapFT, !- Total Cooling Capacity Function of Temperature Curve Name

PackagedRatedCoolCapFFlow, !- Total Cooling Capacity Function of Flow Fraction Curve Name

VarSpeedCoolEIRFT, !- Energy Input Ratio Function of Temperature Curve Name

PackagedRatedCoolEIRFFlow, !- Energy Input Ratio Function of Flow Fraction Curve Name

VarSpeedCyclingPLFFPLR, !- Part Load Fraction Correlation Curve Name

autosize, !- Rated Low Speed Total Cooling Capacity {W}

0.69, !- Rated Low Speed Sensible Heat Ratio

4.2, !- Rated Low Speed COP

autosize, !- Rated Low Speed Air Flow Rate {m3/s}

VarSpeedCoolCapLSFT, !- Low Speed Total Cooling Capacity Function of Temperature Curve Name

VarSpeedCoolEIRLSFT, !- Low Speed Energy Input Ratio Function of Temperature Curve Name

Main Cooling Coil 1 Condenser Node; !- Condenser Air Inlet Node Name

, !- Condenser Type

, !- High Speed Evaporative Condenser Effectiveness {dimensionless}

, !- High Speed Evaporative Condenser Air Flow Rate {m3/s}

, !- High Speed Evaporative Condenser Pump Rated Power Consumption {W}

, !- Low Speed Evaporative Condenser Effectiveness {dimensionless}

, !- Low Speed Evaporative Condenser Air Flow Rate {m3/s}

, !- Low Speed Evaporative Condenser Pump Rated Power Consumption {W}

, !- Supply Water Storage Tank Name

, !- Condensate Collection Water Storage Tank Name

, !- Basin Heater Capacity {W/K}

, !- Basin Heater Setpoint Temperature {C}

, !- Basin Heater Operating Schedule Name

DOAS DX Coil SHR-FT, !- High Speed Sensible Heat Ratio Function of Temperature Curve Name

DOAS DX Coil SHR-FF, !- High Speed Sensible Heat Ratio Function of Flow Fraction Curve Name

DOAS DX Coil SHR-FT, !- Low Speed Sensible Heat Ratio Function of Temperature Curve Name

DOAS DX Coil SHR-FF; !- Low Speed Sensible Heat Ratio Function of Flow Fraction Curve Name

Curve:Quadratic,

DOAS DX Coil SHR-FF, !- Name

0.9317, !- Coefficient1 Constant

-0.0077, !- Coefficient2 x

0.0760, !- Coefficient3 x\*\*2

0.69, !- Minimum Value of x

1.30; !- Maximum Value of x

Curve:Biquadratic,

DOAS DX Coil SHR-FT, !- Name

1.3294540786, !- Coefficient1 Constant

-0.0990649255, !- Coefficient2 x

0.0008310043, !- Coefficient3 x\*\*2

0.0652277735, !- Coefficient4 y

-0.0000793358, !- Coefficient5 y\*\*2

-0.0005874422, !- Coefficient6 x\*y

24.44, !- Minimum Value of x

26.67, !- Maximum Value of x

29.44, !- Minimum Value of y

46.1, !- Maximum Value of y

0.6661, !- Minimum Curve Output

1.6009, !- Maximum Curve Output

Temperature, !- Input Unit Type for X

Temperature, !- Input Unit Type for Y

Dimensionless; !- Output Unit Type

### Coil:Cooling:DX:TwoStageWithHumidityControlMode

### <<Snip>>

### Coil:Cooling:DX:MultiSpeed

This component models a DX cooling unit with multiple discrete levels of cooling capacity. Depending on input choices, the user can model a single compressor with multiple operating speeds, or a unit with a single cooling coil fed by multiple compressors (e.g., row split or intertwined coil circuiting). Currently, this cooling coil can only be referenced by a AirLoopHVAC:UnitaryHeatPump:AirToAir:Multispeed object. Refer to Coil:Cooling:DX:TwoStageWithHumidityControlMode if the user wishes to model a cooling coil with discrete levels of cooling and the possibility of air bypass during low speed operation (e.g. face-split coil circuiting), or if cooling coil operation based on dehumidification requirements is desired.

The multispeed DX cooling coil can have from two to four operating speeds. When the coil operates at Speed 1 (the lowest speed), its performance is very similar to the single speed DX coil where the impacts of part-load ratio and latent capacity degradation can be included. When the coil operates at higher speeds (above Speed 1), the linear approximation methodology is applied. The coil outputs at two consecutive speeds are linearly interpolated to meet the required cooling capacity during an HVAC system timestep. When the coil performs above the lowest speed, the user can chose if they want to include part-load ratio and latent capacity degradation impacts at the higher speeds.

The multispeed unit is described by specifying the performance at different operating speeds. Each speed has its own set of input specifications: full load capacity, SHR, COP and air flow rate at rated conditions, along with modifier curves to determine performance when actual operating conditions are different from the rated conditions.

The coil operates to meet the sensible capacity being requested. When this requested capacity is above the sensible capacity of the highest operating speed, the coil runs continuously at the highest speed. When the requested capacity is between the sensible capacities of two consecutive speeds, the unit will operate a portion of the time at each speed to meet the request. When the requested capacity is less than the low speed (Speed 1) capacity, the unit will cycle on/off as needed.

#### Field: Name

A unique user-assigned name for an instance of a multispeed DX cooling coil. Any reference to this DX coil by another object will use this name.

#### Field: Availability Schedule Name

The name of the schedule (ref: Schedule) that denotes whether the DX cooling coil can run during a given time period. A schedule value greater than 0 (usually 1 is used) indicates that the unit can be on during the time period. A value less than or equal to 0 (usually 0 is used) denotes that the unit must be off for the time period. If this field is blank, the schedule has values of 1 for all time periods.

#### Field: Air Inlet Node Name

The name of the HVAC system node from which the DX cooling coil draws its inlet air.

#### Field: Air Outlet Node Name

The name of the HVAC system node to which the DX cooling coil sends its outlet air.

#### Field: Condenser Air Inlet Node Name

This optional alpha field specifies the outdoor air node name used to define the conditions of the air entering the outdoor condenser. If this field is left blank, the outdoor air temperature entering the condenser (dry-bulb or wet-bulb) is taken directly from the weather data. If this field is not blank, the node name specified must also be specified in an OutdoorAir:Node object where the height of the node is taken into consideration when calculating outdoor air temperature from the weather data. Alternately, the node name may be specified in an OutdoorAir:NodeList object where the outdoor air temperature is taken directly from the weather data.

#### Field: Condenser Type

#### The type of condenser used by the multispeed DX cooling coil. Valid choices for this input field are AirCooled or EvaporativelyCooled. The default for this field is AirCooled.

#### Field: Supply Water Storage Tank Name

This field is optional. It is used to describe where the coil obtains water used for evaporative cooling. If blank or omitted, then the evaporative cooler will obtain water directly from the mains. If the name of a Water Storage Tank object is used here, then the cooler will obtain its water from that tank. If a tank is specified, the coil will attempt to obtain all the water it uses from the tank. However if the tank cannot provide all the water the cooler needs, then the cooler will still operate and obtain the rest of the water it needs from the mains (referred to as StarvedWater).

#### Field: Condensate Collection Water Storage Tank Name

This field is optional. It is used to describe where condensate from the coil is collected. If blank or omitted, then any coil condensate is discarded. Enter the name of Water Storage Tank object defined elsewhere and the condensate will then be collected in that tank.

#### Field: Apply Part Load Fraction to Speeds Greater than 1

This field determines whether part-load impacts on coil energy use are applied when the coil is operating at speeds greater than speed 1. The allowed choices are Yes or No, with the default being No if this field is left blank. Other input fields in this object allow the user to specify a part-load fraction correlation for each speed to account for compressor start up losses (cycle on/off). For the case of a single multi-speed compressor, the part load losses may only be significant when the compressor cycles between speed 1 and off, but the losses may be extremely small when the compressor operates between speed 1 and speed 2 (or between speeds 2 and 3, etc.). In this case, the user may chose to specify NO for this input field to neglect part-load impacts on energy use at higher operating speeds. If part-load impacts on coil energy use are thought to be significant (e.g., interwined cooling coil with multiple compressors feeding individual refrigerant circuits), then the user may chose to specify YES and the part-load fraction correlations specified for speeds 2 through 4 will be applied as appropriate. The selection for this input field does not affect part-load impacts when the compressor cycles between speed 1 and off (i.e., the part-load fraction correlation for speed 1 is always applied).

#### Field: Apply Latent Degradation to Speeds Greater than 1

This field determines whether latent capacity degradation is applied when the coil is operating at speeds greater than speed 1. The allowed choices are Yes or No, with the default being No if this field is left blank. Other input fields in this object allow the user to specify latent capacity degradation at each speed.

The latent capacity degradation model only applies when the ContinuousFanWithCyclingCompressor supply air fan operating mode is specified, to account for moisture evaporation from the wet cooling coil when the compressor cycles off but the supply air fan continues to operate. For the case of a single multi-speed compressor, latent capacity degradation may only be significant when the compressor cycles between speed 1 and off, but the losses may be extremely small when the compressor operates between speed 1 and speed 2 (or between speeds 2 and 3, etc.). In this case, the user may chose to specify NO for this input field to neglect latent capacity degradation impacts at higher operating speeds. If latent capacity degradation is thought to be significant (e.g., interwined or row-split cooling coil with multiple compressors feeding individual refrigerant circuits), then the user may chose to specify YES and the latent capacity degradation model will be applied for speeds 2 through 4 as appropriate. The selection for this input field does not affect latent capacity degradation between speed 1 and off.

#### Field: Crankcase Heater Capacity

This numeric field defines the crankcase heater capacity in Watts. When the outdoor air dry-bulb temperature is below the value specified in the input field “Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation” (described below), the crankcase heater is enabled during the time that the compressor is not running. The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0. To simulate a unit without a crankcase heater, enter a value of 0.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation

This numeric field defines the outdoor air dry-bulb temperature above which the compressor’s crankcase heater is disabled. The value for this input field must be greater than or equal to 0.0°C. If this input field is left blank, the default value is 10°C.

#### Field: Basin Heater Capacity

This numeric field contains the capacity of the DX coil’s electric evaporative cooler basin heater in watts per degree Kelvin. This field only applies for Condenser Type = EvaporativelyCooled. This field is used in conjunction with the Basin Heater Setpoint Temperature described in the following field. The basin heater electric power is equal to this field multiplied by the difference between the basin heater set point temperature and the outdoor dry-bulb temperature. The basin heater only operates when the DX coil is off, regardless of the basin heater schedule described below. The basin heater capacity must be greater than or equal to zero, with a default value of zero if this field is left blank.

#### Field: Basin Heater Setpoint Temperature

This numeric field contains the set point temperature (˚C) for the basin heater described in the previous field. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater is active when the outdoor air dry-bulb temperature falls below this setpoint temperature, as long as the DX coil is off. This set point temperature must be greater than or equal to 2˚C, and the default value is 2˚C if this field is left blank.

#### Field: Basin Heater Operating Schedule Name

This alpha field contains the name of the basin heater operating schedule. This field only applies for Condenser Type = EvaporativelyCooled. The basin heater operating schedule is assumed to be an on/off schedule and the heater is available to operate any time the schedule value is greater than 0. The basin heater operates when scheduled on and the outdoor air dry-bulb temperature is below the set point temperature described in the previous field. If this field is left blank, the basin heater is available to operate throughout the simulation. Regardless of this schedule, the basin heater may only operate when the DX coil is off.

#### Field: Fuel Type

This alpha field determines the type of fuel that this cooling coil uses. This field has seven choices: Electricity, NaturalGas, PropaneGas, Coal, Diesel, Gasoline, FuelOil#1, FuelOil#2, OtherFuel1 and OtherFuel2. The default is NaturalGas.

#### Field: Number of Speeds

This field specifies the number of sets of data being entered for rated specifications, performance curves, evaporative condenser data, latent degradation data, and waste heat specifications for each cooling speed. The rated specifications consist of rated capacity, rated SHR, rated COP, and rated air flow rate. The performance curves consist of a total capacity modifier curve as a function of temperature, total capacity modifier curve as a function of flow fraction, energy input ratio modifier curve as a function of temperature, energy input ratio modifier curve as a function of flow fraction, and part load fraction correlation as a function of part load ratio. The evaporative condenser data consists of effectiveness, condenser air volume flow rate, and rated pump power consumption. The latent degradation data consists of nominal time for condensate removal to begin, ratio of initial moisture evaporation rate and steady-state latent capacity, maximum On/Off cycling rate, and latent capacity time constant. The latent degradation data are only applied if the supply air fan operation mode is specified as ContinuousFanWithCyclingCompressor. The waste heat specifications include the fraction of energy input to the cooling coil at the fully loaded and rated conditions, and a temperature modifier. The minimum number of speeds for cooling is 2 and the maximum number is 4. The number of speeds should be the same as the number of speeds for cooling defined in its parent object (AirLoopHVAC:UnitaryHeatPump:AirToAir:MultiSpeed). The first set of performance inputs is for Speed 1 and should be for low speed, and the last set of performance inputs should be for high speed. For example, if only three cooling speeds are defined, the first set should be for low speed (Speed 1), the second set should be for medium speed (Speed 2), and the third set should be for high speed (Speed 3). In this example, any performance inputs for Speed 4 would be neglected (since this input field specifies that the coil only has three cooling speeds).

#### Field Group: rated specification, performance curves, latent capacity degradation inputs, and evaporative cooled condenser data

The performance for each cooling speed must be specified as shown below. All inputs for Speed 1 are required first, followed by the inputs for Speed 2, Speed 3 and Speed 4.

#### Field: Speed <x> Rated Total Cooling Capacity

The total, full load cooling capacity (sensible plus latent) in watts of the DX coil unit for Speed <x> operation at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb[[3]](#footnote-3), and a cooling coil air flow rate defined by field “Rated Air Volume Flow Rate, Speed <x>” below). Capacity should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Speed <x> Rated Sensible Heat Ratio

The sensible heat ratio (SHR=sensible capacity divided by total cooling capacity) of the DX cooling coil for Speed <x> operation at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “Rated Air Volume Flow Rate, Speed <x>” below). Both the sensible and total cooling capacities used to define the Rated SHR should be “gross” (i.e., supply air fan heat is NOT included).

#### Field: Speed <x> Rated COP

The coefficient of performance (COP=cooling power output in watts divided by electrical power input in watts) of the DX cooling coil unit for Speed <x> operation at rated conditions (air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and a cooling coil air flow rate defined by field “Rated Air Volume Flow Rate, Speed <x>” below). The input power includes power for the compressor(s) and condenser fan(s) but does not include the power consumption of the supply air fan. The cooling power output is the value entered above in the field “Rated Total Cooling Capacity, Speed <x> (gross)”. If this input field is left blank, the default value is 3.0.

#### Field: Speed <x> Rated Air Flow Rate

The volumetric air flow rate for Speed <x>, in m3 per second, across the DX cooling coil at rated conditions. The rated air volume flow rate for Speed <x> should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total cooling capacity for Speed <x>. The rated total cooling capacity, rated SHR and rated COP for Speed <x> should be performance information for the unit with air entering the cooling coil at 26.7°C drybulb/19.4°C wetbulb, air entering the outdoor condenser coil at 35°C drybulb/23.9°C wetbulb, and the rated air volume flow rate defined here.

***Field: Speed <X> Rated Evaporator Fan Power Per Volume Flow Rate***

This field is the electric power for the evaporator (cooling coil) fan per air volume flow rate through the coil at the rated conditions for Speed <x> in W/(m3/s). The default value is 773.3 W/(m3/s) (365 W/1000 cfm) if this field is left blank. If a value is entered, it must be >= 0.0 and <= 1250 W/(m3/s). This value is only used to calculate Seasonal Energy Efficiency Ratio (SEER), and the Standard Rating (Net) Cooling Capacity which will be outputs in the EnergyPlus eio file (ref. EnergyPlus Engineering Reference, Multi-Speed DX Cooling Coil, Standard Ratings). This value is not used for modeling the evaporator (cooling coil) fan during simulations; instead, it is used for calculating SEER and Standard Rating Cooling Capacity to assist the user in verifying their inputs for modeling this type of equipment.

#### Field: Speed <x> Total Cooling Capacity Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the total cooling capacity for Speed <x> as a function of the wet-bulb temperature of the air entering the cooling coil, and the dry-bulb temperature of the air entering the air-cooled condenser (wet-bulb temperature if modeling an evaporative-cooled condenser). The output of this curve is multiplied by the rated total cooling capacity for Speed <x> to give the total cooling capacity at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Speed <x> Total Cooling Capacity Function of Flow Fraction Curve Name

The name of a quadratic performance curve (ref: Performance Curves) that parameterizes the variation of total cooling capacity for Speed <x> as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate for Speed <x> (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total cooling capacity and the total cooling capacity modifier curve (function of temperature) to give the total cooling capacity for Speed <x> at the specific temperature and air flow conditions at which the coil is operating. The curve is normalized to have the value of 1.0 when the actual air flow rate equals the rated air flow rate for Speed <x>.

#### Field: Speed <x> Energy Input Ratio Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) for Speed <x> as a function of the wetbulb temperature of the air entering the cooling coil and the drybulb temperature of the air entering the air-cooled condenser (wetbulb temperature if modeling an evaporative-cooled condenser). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR for Speed <x> (inverse of rated COP for Speed <x>) to give the EIR for Speed <x> at specific temperature operating conditions (i.e., at temperatures different from the rating point temperatures). The curve is normalized to a value of 1.0 at the rating point.

#### Field: Speed <x> Energy Input Ratio Function of Flow Fraction Curve Name

The name of a quadratic performance curve (Ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) for Speed <x> as a function of the ratio of actual air flow rate across the cooling coil to the rated air flow rate for Speed <x> (i.e., fraction of full load flow). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR and the EIR modifier curve (function of temperature) to give the EIR for Speed <x> at the specific temperature and air flow conditions at which the cooling coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate for Speed <x>.

#### Field: Speed <x> Part Load Fraction Correlation Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (Ref: Performance Curves) that parameterizes the variation of electrical power input to the DX unit as a function of the part load ratio (PLR, sensible cooling load/steady-state sensible cooling capacity for Speed <x>). The product of the rated EIR and EIR modifier curves is divided by the output of this curve to give the “effective” EIR for a given simulation timestep for Speed <x>. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling.

The part load fraction correlation should be normalized to a value of 1.0 when the part load ratio equals 1.0 (i.e., no efficiency losses when the compressor(s) run continuously for the simulation timestep). For PLR values between 0 and 1 (0 <= PLR < 1), the following rules apply:

PLF >= 0.7 and PLF >= PLR

If PLF < 0.7 a warning message is issued, the program resets the PLF value to 0.7, and the simulation proceeds. The runtime fraction of the coil is defined as PLR/PLF. If PLF < PLR, then a warning message is issued and the runtime fraction of the coil is limited to 1.0.

A typical part load fraction correlation for a conventional DX cooling coil (Speed <x>) would be:

PLF = 0.85 + 0.15(PLR)

If the user wishes to model no efficiency degradation due to compressor cycling, the part load fraction correlation should be defined as follows:

PLF = 1.0 + 0.0(PLR)

#### Field: Speed <x> Nominal Time for Condensate Removal to Begin

For Speed <x>, the nominal time (in seconds) after startup for condensate to begin leaving the coil's condensate drain line at the coil's rated airflow and temperature conditions, starting with a dry coil. Nominal time is equal to the ratio of the energy of the coil's maximum condensate holding capacity (J) to the coil's steady-state latent capacity (W). Suggested value is 1000; zero value means the latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]), and this field as well as the next three input fields for this object must have positive values in order to model latent capacity degradation for Speed <x>.

#### Field: Speed <x> Ratio of Initial Moisture Evaporation Rate and Steady State Latent Capacity

For Speed <x>, the ratio of the initial moisture evaporation rate from the cooling coil (when the compressor first turns off, in Watts) and the coil's steady-state latent capacity (Watts) for Speed <x> at rated airflow and temperature conditions. Suggested value is 1.5; zero value means the latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]); and this field, the previous field and the next two fields must have positive values in order to model latent capacity degradation for Speed <x>.

#### Field: Speed <x> Maximum Cycling Rate

For Speed <x>, the maximum on-off cycling rate for the compressor (cycles per hour), which occurs at 50% run time fraction. Suggested value is 3; zero value means latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]); and this field, the previous two fields and the next field must have positive values in order to model latent capacity degradation for Speed <x>.

#### Field: Speed <x> Latent Capacity Time Constant

For Speed <x>, the time constant (in seconds) for the cooling coil's latent capacity to reach steady state after startup. Suggested value is 45; zero value means latent degradation model is disabled. The default value for this field is zero. The supply air fan operating mode must be continuous (i.e., the supply air fan operating mode may be specified in other ”parent” objects and is assumed continuous in some objects (e.g., CoilSystem:Cooling:DX) or can be scheduled in other objects [e.g., AirloopHVAC:UnitaryHeatCool]), and this field as well as the previous three input fields for this object must have positive values in order to model latent capacity degradation for Speed <x>.

#### Field: Speed <x> Rated Waste Heat Fraction of Power Input

The fraction of energy input to the cooling coil that is available as recoverable waste heat at full load and rated conditions for Speed <x>.

#### Field: Speed <x> Waste Heat Function of Temperature Curve Name

The name of a biquadratic performance curve (ref: Performance Curves) that parameterizes the variation of the waste heat recovery as a function of outdoor dry-bulb temperature and the entering coil dry-bulb temperature at Speed <x>. The output of this curve is multiplied by the rated waste heat fraction at specific temperature operating conditions (i.e., at temperatures different from the rating point). The curve is normalized to a value of 1.0 at the rating point. When the fuel type is electricity, this field can remain blank since it is ignored by the program in this instance.

#### Field: Speed <x> Evaporative Condenser Effectiveness

The effectiveness of the evaporative condenser at Speed <x>, which is used to determine the temperature of the air entering the outdoor condenser coil as follows:



where

*Tcond inlet* = the temperature of the air entering the condenser coil (C)

*Twb,o*= the wet-bulb temperature of the outdoor air (C)

*Tdb,o*= the dry-bulb temperature of the outdoor air (C)

The resulting condenser inlet air temperature is used by the Total Cooling Capacity Modifier Curve, Speed <x> (function of temperature) and the Energy Input Ratio Modifier Curve, Speed <x> (function of temperature). The default value for this field is 0.9, although valid entries can range from 0.0 to 1.0. This field is not used when Condenser Type = Air Cooled.

If the user wants to model an air-cooled condenser, they should simply specify AirCooled in the field Condenser Type. In this case, the Total Cooling Capacity Modifier Curve, Speed <x> (function of temperature) and the Energy Input Ratio Modifier Curve, Speed <x> (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature.

If the user wishes to model an evaporative-cooled condenser AND they have performance curves that are a function of the wet-bulb temperature of air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled and the evaporative condenser effectiveness value should be entered as 1.0. In this case, the Total Cooling Capacity Modifier Curve, Speed <x> (function of temperature) and the Energy Input Ratio Modifier Curve, Speed <x> (function of temperature) input fields for this object should reference performance curves that are a function of the wet-bulb temperature of air entering the condenser coil.

If the user wishes to model an air-cooled condenser that has evaporative media placed in front of it to cool the air entering the condenser coil, then the user should specify Condenser Type = Evap Cooled. The user must also enter the appropriate evaporative effectiveness for the media. In this case, the Total Cooling Capacity Modifier Curve, Speed <x> (function of temperature) and the Energy Input Ratio Modifier Curve, Speed <x> (function of temperature) input fields for this object should reference performance curves that are a function of outdoor dry-bulb temperature. Be aware that the evaporative media will significantly reduce the dry-bulb temperature of the air entering the condenser coil, so the Total Cooling Capacity and EIR Modifier Curves for Speed <x> must be valid for the expected range of dry-bulb temperatures that will be entering the condenser coil.

#### Field: Speed <x> Evaporative Condenser Air Flow Rate

The air volume flow rate, in m3 per second, entering the evaporative condenser at Speed <x>. This value is used to calculate the amount of water used to evaporatively cool the condenser inlet air. The minimum value for this field must be greater than zero, and this input field is autosizable (equivalent to 0.000114 m3/s per watt of rated total cooling capacity for Speed <x> [850 cfm/ton]). This field is not used when Condenser Type = Air Cooled.

#### Field: Speed <x> Rated Evaporative Condenser Pump Power Consumption

The rated power of the evaporative condenser water pump in Watts at Speed <x>. This value is used to calculate the power required to pump the water used to evaporatively cool the condenser inlet air. The default value for this input field is zero, but it is autosizable (equivalent to 0.004266 W per watt [15 W/ton] of rated total capacity for Speed <x>). This field is not used when Condenser Type = Air Cooled.

#### Field: Zone Name for Condenser Placement

This input field is name of a conditioned or unconditioned zone where the secondary coil (condenser) of DX system or a heat pump is to be placed. This is an optional input field specified only when user desires to reject the condenser heat into a zone. The heat rejected is modeled as sensible internal gain of a secondary zone.

Following is an example input for this multispeed DX cooling coil.

Coil:Cooling:DX:MultiSpeed,

Heat Pump ACDXCoil 1, !- Coil Name

FanAndCoilAvailSched, !- Availability Schedule

DX Cooling Coil Air Inlet Node, !- Coil Air Inlet Node

Heating Coil Air Inlet Node, !- Coil Air Outlet Node

Outdoor Condenser Air Node, !- Condenser Air Inlet Node Name

AirCooled, !- Condenser Type

, !- Name of Water Storage Tank for Supply

, !- Name of Water Storage Tank for Condensate Collection

No, !- Apply Part Load Fraction to Speeds greater than 1

No, !- Apply latent degradation to Speeds greater than 1

200.0, !- Crankcase Heater Capacity {W}

10.0, !- Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation

, !- Basin Heater Capacity {W/K}

, !- Basin Heater Setpoint Temperature {C}

, !- Basin Heater Operating Schedule Name

NaturalGas, !- Fuel Type

4, !- Number of speeds

7500, !- Rated Total Cooling Capacity, Speed 1 (gross) {W}

0.75, !- Rated SHR, Speed 1 {dimensionless}

3.0, !- Rated COP, Speed 1 {dimensionless}

0.40, !- Rated Air Volume Flow Rate, Speed 1 {m3/s}

, !- Rated Evaporator Fan Power Per Volume Flow Rate, Speed 1 {W/(m3/s)}

HPACCoolCapFT Speed 1, !- Total Cooling Capacity Modifier Curve, Speed 1 (temperature)

HPACCoolCapFF Speed 1, !- Total Cooling Capacity Modifier Curve, Speed 1 (flow fraction)

HPACCOOLEIRFT Speed 1, !- Energy Input Ratio Modifier Curve, Speed 1 (temperature)

HPACCOOLEIRFF Speed 1, !- Energy Input Ratio Modifier Curve, Speed 1 (flow fraction)

HPACCOOLPLFFPLR Speed 1, !- Part Load Fraction Correlation, Speed 1 (part load ratio)

1000.0, !- Nominal Time for Condensate Removal to Begin, Speed 1 {s}

1.5, !- Ratio of Initial Moisture Evaporation Rate and Steady-state Latent

3.0, !- Maximum ON/OFF Cycling Rate, Speed 1 {cycles/hr}

45.0, !- Latent Capacity Time Constant, Speed 1 {s}

0.2, !- Rated waste heat fraction of power input, Speed 1 {dimensionless}

HAPCCoolWHFT Speed 1, !- Waste heat modifier curve, Speed 1 (temperature)

0.9, !- Evaporative Condenser Effectiveness, Speed 1 {dimensionless}

0.05, !- Evaporative Condenser Air Volume Flow Rate, Speed 1 {m3/s}

50, !- Evaporative Condenser Pump Rated Power Consumption, Speed 1 {W}

17500, !- Rated Total Cooling Capacity, Speed 2 (gross) {W}

0.75, !- Rated SHR, Speed 2 {dimensionless}

3.0, !- Rated COP, Speed 2 {dimensionless}

0.85, !- Rated Air Volume Flow Rate, Speed 2 {m3/s}

, !- Rated Evaporator Fan Power Per Volume Flow Rate, Speed 2 {W/(m3/s)}

HPACCoolCapFT Speed 2, !- Total Cooling Capacity Modifier Curve, Speed 2 (temperature)

HPACCoolCapFF Speed 2, !- Total Cooling Capacity Modifier Curve, Speed 2 (flow fraction)

HPACCOOLEIRFT Speed 2, !- Energy Input Ratio Modifier Curve, Speed 2 (temperature)

HPACCOOLEIRFF Speed 2, !- Energy Input Ratio Modifier Curve, Speed 2 (flow fraction)

HPACCOOLPLFFPLR Speed 1, !- Part Load Fraction Correlation, Speed 2 (part load ratio)

1000.0, !- Nominal Time for Condensate Removal to Begin, Speed 2

1.5, !- Ratio of Initial Moisture Evaporation Rate and Steady-state Latent

3.0, !- Maximum ON/OFF Cycling Rate, Speed 2

45.0, !- Latent Capacity Time Constant, Speed 2

0.2, !- Rated waste heat fraction of power input, Speed 2 {dimensionless}

HAPCCoolWHFT Speed 2, !- Waste heat modifier curve, Speed 2 (temperature)

0.9, !- Evaporative Condenser Effectiveness, Speed 2 {dimensionless}

0.1, !- Evaporative Condenser Air Volume Flow Rate, Speed 2 {m3/s}

60, !- Evaporative Condenser Pump Rated Power Consumption, Speed 2 {W}

25500, !- Rated Total Cooling Capacity, Speed 3 (gross) {W}

0.75, !- Rated SHR, Speed 3 {dimensionless}

3.0, !- Rated COP, Speed 3 {dimensionless}

1.25, !- Rated Air Volume Flow Rate, Speed 3 {m3/s}

, !- Rated Evaporator Fan Power Per Volume Flow Rate, Speed 3 {W/(m3/s)}

HPACCoolCapFT Speed 3, !- Total Cooling Capacity Modifier Curve, Speed 3 (temperature)

HPACCoolCapFF Speed 3, !- Total Cooling Capacity Modifier Curve, Speed 3 (flow fraction)

HPACCOOLEIRFT Speed 3, !- Energy Input Ratio Modifier Curve, Speed 3 (temperature)

HPACCOOLEIRFF Speed 3, !- Energy Input Ratio Modifier Curve, Speed 3 (flow fraction)

HPACCOOLPLFFPLR Speed 1, !- Part Load Fraction Correlation, Speed 3 (part load ratio)

1000.0, !- Nominal Time for Condensate Removal to Begin, Speed 3 {s}

1.5, !- Ratio of Initial Moisture Evaporation Rate and Steady-state Latent

3.0, !- Maximum ON/OFF Cycling Rate, Speed 3 {cycles/hr}

45.0, !- Latent Capacity Time Constant, Speed 3 {s}

0.2, !- Rated waste heat fraction of power input, Speed 3 {dimensionless}

HAPCCoolWHFT Speed 3, !- Waste heat modifier curve, Speed 3 (temperature)

0.9, !- Evaporative Condenser Effectiveness, Speed 3 {dimensionless}

0.2, !- Evaporative Condenser Air Volume Flow Rate, Speed 3 {m3/s}

80, !- Evaporative Condenser Pump Rated Power Consumption, Speed 3 {W}

35500, !- Rated Total Cooling Capacity, Speed 4 (gross) {W}

0.75, !- Rated SHR, Speed 4 {dimensionless}

3.0, !- Rated COP, Speed 4 {dimensionless}

1.75, !- Rated Air Volume Flow Rate, Speed 4 {m3/s}

, !- Rated Evaporator Fan Power Per Volume Flow Rate, Speed 4 {W/(m3/s)}

HPACCoolCapFT Speed 4, !- Total Cooling Capacity Modifier Curve, Speed 4 (temperature)

HPACCoolCapFF Speed 4, !- Total Cooling Capacity Modifier Curve, Speed 4 (flow fraction)

HPACCOOLEIRFT Speed 4, !- Energy Input Ratio Modifier Curve, Speed 4 (temperature)

HPACCOOLEIRFF Speed 4, !- Energy Input Ratio Modifier Curve, Speed 4 (flow fraction)

HPACCOOLPLFFPLR Speed 1, !- Part Load Fraction Correlation, Speed 4 (part load ratio)

1000.0, !- Nominal Time for Condensate Removal to Begin, Speed 4 {s}

1.5, !- Ratio of Initial Moisture Evaporation Rate and Steady-state Latent !- Capacity, Speed 4 {dimensionless}

3.0, !- Maximum ON/OFF Cycling Rate, Speed 4 {cycles/hr}

45.0, !- Latent Capacity Time Constant, Speed 4 {s}

0.2, !- Rated waste heat fraction of power input, Speed 4 {dimensionless}

HAPCCoolWHFT Speed 4, !- Waste heat modifier curve, Speed 4 (temperature)

0.9, !- Evaporative Condenser Effectiveness, Speed 4 {dimensionless}

0.3, !- Evaporative Condenser Air Volume Flow Rate, Speed 4 {m3/s}

100; !- Evaporative Condenser Pump Rated Power Consumption, Speed 4 {W}

### DX Cooling Coil Outputs

HVAC,Average,Cooling Coil Total Cooling Rate [W]

HVAC,Sum,Cooling Coil Total Cooling Energy [J]

HVAC,Average,Cooling Coil Sensible Cooling Rate [W]

HVAC,Sum,Cooling Coil Sensible Cooling Energy [J]

HVAC,Average,Cooling Coil Latent Cooling Rate [W]

HVAC,Sum,Cooling Coil Latent Cooling Energy [J]

HVAC,Average,Cooling Coil Electric Power[W]

HVAC,Sum,Cooling Coil Electric Energy [J]

HVAC,Average,Cooling Coil Runtime Fraction []

If not part of AirLoopHVAC:UnitaryHeatPump:AirToAir (if part of a heat pump, crankcase heater is reported only for the heating coil):

HVAC,Average,Cooling Coil Crankcase Heater Electric Power[W]

HVAC,Sum,Cooling Coil Crankcase Heater Electric Energy [J]

Evaporative-cooled condenser:

HVAC,Average,Cooling Coil Condenser Inlet Temperature [C]

HVAC,Sum,Cooling Coil Evaporative Condenser Water Volume[m3]

HVAC,Average,Cooling Coil Evaporative Condenser Pump Electric Power[W]

HVAC,Sum,Cooling Coil Evaporative Condenser Pump Electric Energy [J]

HVAC,Average,Cooling Coil Basin Heater Electric Power[W]

HVAC,Sum,Cooling Coil Basin Heater Electric Energy [J]

HVAC,Sum,Cooling Coil Evaporative Condenser Mains Supply Water Volume [m3]

Additional variables for Coil:Cooling:DX:TwoStageWithHumidityControlMode only:

HVAC,Average,Cooling Coil Stage 2 Runtime Fraction []

HVAC,Average,Cooling Coil Dehumidification Mode []

Additional variables when condensate is collected using a storage tank:

HVAC,Average,Cooling Coil Condensate Volume Flow Rate [m3/s]

Zone,Meter,Condensate:OnSiteWater [m3]

HVAC,Sum,Cooling Coil Condensate Volume [m3]

Additional variables for Coil:Cooling:DX:Multispeed:

If Fuel Type is not Electricity:

HVAC,Average,DX Cooling Coil <Fuel Type> Power[W]

HVAC,Sum,DX Cooling Coil <Fuel Type> Consumption[J]

#### Cooling Coil Total Cooling Rate [W]

This field is the total (sensible and latent) cooling rate output of the DX coil in Watts. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil.

#### Cooling Coil Total Cooling Energy [J]

This is the total (sensible plus latent) cooling output of the DX coil in Joules over the timestep being reported. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil. This output is also added to a meter with Resource Type = EnergyTransfer, End Use Key = CoolingCoils, Group Key = System (Ref. Output:Meter object).

#### Cooling Coil Sensible Cooling Rate [W]

This output is the moist air sensible cooling rate output of the DX coil in Watts. This is determined by the inlet and outlet air conditions and the air mass flow rate through the coil.

#### Cooling Coil Sensible Cooling Energy [J]

This is the moist air sensible cooling output of the DX coil in Joules for the timestep being reported. This is determined by the inlet and outlet air conditions and the air mass flow rate through the coil.

#### Cooling Coil Latent Cooling Rate [W]

This is the latent cooling rate output of the DX coil in Watts. This is determined by the inlet and outlet air conditions and the air mass flow rate through the coil.

#### Cooling Coil Latent Cooling Energy [J]

This is the latent cooling output of the DX coil in Joules for the timestep being reported. This is determined by the inlet and outlet air conditions and the air mass flow rate through the coil.

#### Cooling Coil Electric Power [W]

This output is the electricity consumption rate of the DX coil compressor and condenser fan(s) in Watts. This value is calculated for each HVAC system timestep, and the results are averaged for the timestep being reported.

#### Cooling Coil Electric Energy [J]

This is the electricity consumption of the DX coil compressor and condenser fan(s) in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Cooling, Group Key = System (Ref. Output:Meter object).

#### Cooling Coil Runtime Fraction []

This is the runtime fraction of the DX coil compressor and condenser fan(s) for the timestep being reported.

#### Cooling Coil Crankcase Heater Electric Power[W]

This is the average electricity consumption rate of the DX coil compressor’s crankcase heater in Watts for the timestep being reported. If the DX Cooling Coil is used in a heat pump, the crankcase heater is reported only for the heating coil.

#### Cooling Coil Crankcase Heater Electric Energy [J]

This is the electricity consumption of the DX coil compressor’s crankcase heater in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Cooling, Group Key = System (ref. Output:Meter object). This output variable appears only when the DX Cooling Coil is not used as part of a heat pump, otherwise the crankcase heater is reported only for the heating coil.

#### Cooling Coil Condenser Inlet Temperature [C]

This is the inlet air temperature to the condenser coil in degrees C. This value can represent the outdoor air dry-bulb temperature, wet-bulb temperature, or somewhere in between from the weather data being used, depending on the value used in the input field “Evaporative Condenser Effectiveness”. The temperature reported here is used in the various modifier curves related to temperature (e.g., Total Cooling Capacity Modifier Curve [function of temperature]). This output variable appears only when the DX Cooling Coil is not used as part of a heat pump, otherwise the crankcase heater is reported only for the heating coil.

#### Cooling Coil Evaporative Condenser Water Volume [m3]

This output is the amount of water used to evaporatively cool the condenser coil inlet air, in cubic meters. This output is also added to a meter with Resource Type = Water, End Use Key = Cooling, Group Key = System (ref. Output:Meter object). This output variable appears only when the DX Cooling Coil is evaporatively cooled.

#### Cooling Coil Evaporative Condenser Mains Supply Water Volume [m3]

This is the volume of water drawn from mains water service for the evaporatively cooled condenser.

#### Cooling Coil Evaporative Condenser Pump Electric Power [W]

This is the average electricity consumption rate of the evaporative condenser water pump in Watts for the timestep being reported. This output variable appears only when the DX Cooling Coil is evaporatively cooled.

#### Cooling Coil Evaporative Condenser Pump Electric Energy [J]

This is the electricity consumption rate of the evaporative condenser water pump in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Cooling, Group Key = System (ref. Output:Meter object). This output variable appears only when the DX Cooling Coil is evaporatively cooled.

#### Cooling Coil Stage 2 Runtime Fraction []

This is the runtime fraction of the stage 2 DX coil compressor and condenser fan(s) for the timestep being reported. Applicable only for COIL Coil:Cooling:DX:TwoStageWithHumidityControlMode when 2 capacity stages are specified. For 2-stage systems, Cooling Coil Runtime Fraction is the stage 1 runtime fraction. These runtime fractions overlap, because stage 2 will not run unless stage 1 is already running. For example, a system where stage 1 is 60% of total capacity is passed a load of 70%. The Cooling Coil Runtime Fraction (stage 1) will be 1.0, and the Cooling Coil Stage 2 Runtime Fraction will be 0.25 [(70%-60%)/(100%-60%)].

#### Cooling Coil Dehumidification Mode []

This is the dehumidification mode for the timestep being reported. Applicable only for Coil:Cooling:DX:TwoStageWithHumidityControlMode when enhanced dehumidification mode is available. A value of 0 indicates normal mode (extra dehumidification not active). A value of 1 indicates dehumidification mode 1 is active. Note that this is an averaged variable, so fractional values are likely to be reported for reporting frequencies longer than "detailed".

#### Cooling Coil Condensate Volume Flow Rate [m3/s]

#### Cooling Coil Condensate Volume [m3]

These outputs are the rate and volume of water collected as condensate from the coil. These reports only appear if a water storage tank is named in the input object.

#### Cooling Coil Evaporative Condenser Mains Supply Water Volume [m3]

This is the water consumed by the DX Cooling Coil evaporatively cooled condenser that is met by the mains water. This output variable appears only when the DX Cooling Coil is evaporatively cooled.

#### Cooling Coil Basin Heater Electric Power [W]

This is the average electricity consumption rate of the basin heater in Watts for the timestep being reported. This output variable appears only when the DX Cooling Coil is evaporatively cooled and the Basin Heater Capacity is greater than 0.

#### Cooling Coil Basin Heater Electric Energy [J]

This is the electricity consumption rate of the basin heater in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Cooling, Group Key = System (ref. Output:Meter object). This output variable appears only when the DX Cooling Coil is evaporatively cooled and the Basin Heater Capacity is greater than 0.

#### Cooling Coil <Fuel Type> Power [W]

This output variable appears only when using the Coil:Cooling:DX:Multispeed object and a fuel type other than electricity is used. This variable describes the input fuel type power for the cooling coil in Watts, averaged during the timestep being reported.

#### Cooling Coil <Fuel Type> Energy [J]

This output variable appears only when using the Coil:Cooling:DX:Multispeed object and a fuel type other than electricity is used. This variable describes the input fuel type consumption for the multispeed cooling coil in the unit of Joules, summed for the timestep being reported. The electric consumption is excluded..This output is added to a meter with Resource Type = <Fuel Type>, End Use Key = Cooling, Group Key = System (ref. Output:Meter object).

Note: <Fuel Type> in the above two output variables depends on the user specified input for the Fuel Type field. In addition to Electricity, valid fuel types are NaturalGas, Propane, FuelOil#1, FuelOil#2, Coal, Diesel, Gasoline, OtherFuel1 and OtherFuel2.

### Coil:Cooling:DX:VariableSpeed

<<Snip>>

### Coil:Heating:DX:SingleSpeed

The single speed heating DX coil model uses performance information at rated conditions along with curve fits for variations in total capacity, energy input ratio and part load fraction to determine performance at part-load conditions. The impacts of various defrost strategies (reverse cycle, resistive, timed or on-demand) are modeled based on a combination of user inputs and empirical models taken from the air-to-air heat pump algorithms in DOE-2.1E.

The single speed heating DX coil input requires an availability schedule, the rated total heating capacity, the rated COP and the rated air volume flow rate. The latter 3 inputs determine the coil performance at the rating point (outdoor air dry-bulb temperature of 8.33 C, outdoor air wet-bulb temperature of 6.11 C, coil entering air dry-bulb temperature of 21.11 C, coil entering air wet-bulb temperature of 15.55 C). The rated air volume flow rate should be between .00004027 m3/s and .00006041 m3/s per watt of rated total heating capacity.

Up to 6 curves are required depending on the defrost strategy selected.

1. The total heating capacity modifier curve (function of temperature) can be a function of both the outdoor and indoor air dry-bulb temperature or only the outdoor air dry-bulb temperature. User has the choice of a bi-quadratic curve with two independent variables or a quadratic curve as well as a cubic curve with a single independent variable. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated total heating capacity to give the total heating capacity at specific temperature operating conditions (i.e., at an outdoor or indoor air temperature different from the rating point temperature).
2. The total heating capacity modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total heating capacity and the total heating capacity modifier curve (function of temperature) to give the total heating capacity at the specific temperature and air flow conditions at which the coil is operating.
3. The energy input ratio (EIR) modifier curve (function of temperature) can be a function of both the outdoor and indoor air dry-bulb temperature or only the outdoor air dry-bulb temperature. User has the choice of a bi-quadratic curve with two independent variables or a quadratic curve as well as a cubic curve with a single independent variable. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated EIR (inverse of the rated COP) to give the EIR at specific temperature operating conditions (i.e., at an outdoor or indoor air temperature different from the rating point temperature).
4. The energy input ratio (EIR) modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated EIR (inverse of the rated COP) and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the coil is operating.
5. The part load fraction correlation (function of part load ratio) is a quadratic or cubic curve with the independent variable being part load ratio (sensible heating load / steady-state heating capacity). The output of this curve is used in combination with the rated EIR and EIR modifier curves to give the “effective” EIR for a given simulation timestep. The part load fraction correlation accounts for efficiency losses due to compressor cycling.
6. The defrost energy input ratio (EIR) modifier curve (function of temperature) is a bi-quadratic curve with two independent variables: outdoor air dry-bulb temperature and the heating coil entering air wet-bulb temperature. The output of this curve is multiplied by the heating coil capacity, the fractional defrost time period and the runtime fraction of the heating coil to give the defrost power at the specific temperatures at which the coil is operating. This curve is only required when a reverse-cycle defrost strategy is specified.

The curves are simply specified by name. Curve inputs are described in the curve manager section of this document (ref. Performance Curves).

The next input item for the coil is the supply air fan operation mode. Either the supply air fan runs continuously while the DX coil cycles on/off, or the fan and coil cycle on/off together. The next two inputs define the minimum outdoor dry-bulb temperature that the heat pump compressor will operate and the maximum outdoor dry-bulb temperature for defrost operation. Crankcase heater capacity and cutout temperature are entered in the following two inputs. The final four inputs cover the type of defrost strategy (reverse-cycle or resistive), defrost control (timed or on-demand), the fractional defrost time period (timed defrost control only), and the resistive defrost heater capacity if a resistive defrost strategy is selected.

#### Field: Name

This alpha field defines a unique user-assigned name for an instance of a DX heating coil. Any reference to this DX heating coil by another object will use this name.

#### Field: Availability Schedule Name

This alpha field defines the name of the schedule (ref: Schedule) that denotes whether the DX heating coil can run during a given time period. A schedule value greater than 0 (usually 1 is used) indicates that the unit can be on during the time period. A value less than or equal to 0 (usually 0 is used) denotes that the unit must be off for the time period. If this field is blank, the schedule has values of 1 for all time periods.

#### Field: Rated Total Heating Capacity

This numeric field defines the total, full load heating capacity in watts of the DX coil unit at rated conditions (outdoor air dry-bulb temperature of 8.33 C, outdoor air wet-bulb temperature of 6.11 C, heating coil entering air dry-bulb temperature of 21.11 C, heating coil entering air wet-bulb temperature of 15.55 C, and a heating coil air flow rate defined by field “rated air flow volume” below). The value entered here must be greater than 0. Capacity should not include supply air fan heat. The rated total heating capacity should be within 20% of the rated total cooling capacity, otherwise a warning message is issued.

#### Field: Rated COP

This numeric field defines the coefficient of performance (COP=heating power output in watts divided by electrical power input in watts) of the DX heating coil unit at rated conditions (outdoor air dry-bulb temperature of 8.33 C, outdoor air wet-bulb temperature of 6.11 C, coil entering air dry-bulb temperature of 21.11 C, coil entering air wet-bulb temperature of 15.55 C, and a heating coil air flow rate defined by field “rated air flow volume rate” below). The value entered here must be greater than 0. The input power includes power for the compressor(s) and outdoor fan(s) but does not include the power consumption of the indoor supply air fan. The heating power output is the value entered above in the field “Rated Total Heating Capacity”.

#### Field: Rated Air Flow Rate

This numeric field defines the volume air flow rate, in m3 per second, across the DX heating coil at rated conditions. The value entered here must be greater than 0. The rated air volume flow rate should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total heating capacity. The rated total heating capacity and rated COP should be performance information for the unit with outdoor air dry-bulb temperature of 8.33 C, outdoor air wet-bulb temperature of 6.11 C, heating coil entering air dry-bulb temperature of 21.11 C, heating coil entering air wet-bulb temperature of 15.55 C, and the rated air volume flow rate defined here.

#### Field: Rated Evaporator Fan Power Per Volume Flow Rate

This field is the electric power for the evaporator (heating coil) fan per air volume flow rate through the coil at the rated conditions in W/(m3/s). The default value is 773.3 W/(m3/s) (365 W/1000 cfm) if this field is left blank. If a value is entered, it must be >= 0.0 and <= 1250 W/(m3/s). This value is only used to calculate High Temperature Heating Standard (Net) Rating Capacity, Low Temperature Heating Standard (Net) Rating Capacity and Heating Seasonal Performance Factor (HSPF) which will be outputs in the EnergyPlus eio file (ref. EnergyPlus Engineering Reference, Single Speed DX Heating Coil, Standard Ratings). This value is not used for modeling the evaporator (heating coil) fan during simulations; instead, it is used for calculating the above standard ratings to assist the user in verifying their inputs for modeling this type of equipment.

#### Field: Air Inlet Node Name

This alpha field defines the name of the HVAC system node from which the DX heating coil draws its inlet air.

#### Field: Air Outlet Node Name

This alpha field defines the name of the HVAC system node to which the DX heating coil sends its outlet air.

#### Field: Total Heating Capacity Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic, quadratic or cubic performance curve (ref: Performance Curves) that parameterizes the variation of the total heating capacity as a function of the both the indoor and outdoor air dry-bulb temperature or just the outdoor air dry-bulb temperature depending on the type of curve selected. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated total heating capacity to give the total heating capacity at specific temperature operating conditions (i.e., at an indoor air dry-bulb temperature or outdoor air dry-bulb temperature different from the rating point temperature). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Total Heating Capacity Function of Flow Fraction Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (ref: Performance Curves) that parameterizes the variation of total heating capacity as a function of the ratio of actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total heating capacity and the total heating capacity modifier curve (function of temperature) to give the total heating capacity at the specific temperature and air flow conditions at which the coil is operating. The curve is normalized to have the value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Energy Input Ratio Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic, quadratic or cubic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the both the indoor and outdoor air dry-bulb temperature or just the outdoor air dry-bulb temperature depending on the type of curve selected. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR (inverse of rated COP) to give the EIR at specific temperature operating conditions (i.e., at an indoor air dry-bulb temperature or outdoor air dry-bulb temperature different from the rating point temperature). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Energy Input Ratio Function of Flow Fraction Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the ratio of actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Part Load Fraction Correlation Curve Name

This alpha field defines the name of a quadratic or cubic performance curve (Ref: Performance Curves) that parameterizes the variation of electrical power input to the DX unit as a function of the part load ratio (PLR, sensible cooling load/steady-state sensible cooling capacity). The product of the rated EIR and EIR modifier curves is divided by the output of this curve to give the “effective” EIR for a given simulation timestep. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling.

The part load fraction correlation should be normalized to a value of 1.0 when the part load ratio equals 1.0 (i.e., no efficiency losses when the compressor(s) run continuously for the simulation timestep). For PLR values between 0 and 1 (0 <= PLR < 1), the following rules apply:

PLF >= 0.7 and PLF >= PLR

If PLF < 0.7 a warning message is issued, the program resets the PLF value to 0.7, and the simulation proceeds. The runtime fraction of the coil is defined as PLR/PLF. If PLF < PLR, then a warning message is issued and the runtime fraction of the coil is limited to 1.0.

A typical part load fraction correlation for a conventional, single-speed DX cooling coil (e.g., residential unit) would be:

PLF = 0.85 + 0.15(PLR)

If the user wishes to model no efficiency degradation due to compressor cycling, the part load fraction correlation should be defined as follows:

PLF = 1.0 + 0.0(PLR)

#### Field: Defrost Energy Input Ratio Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) during reverse-cycle defrost periods as a function of the outdoor air dry-bulb temperature and the wet-bulb temperature of the air entering the indoor coil. The EIR is the inverse of the COP. The output of this curve is multiplied by the coil capacity, the fractional defrost time period and the runtime fraction of the heating coil to give the defrost power at the specific temperatures at which the indoor and outdoor coils are operating. This curve is only required when a reverse-cycle defrost strategy is selected. The curve is normalized to a value of 1.0 at the rating point conditions.

#### Field: Minimum Outdoor Dry-Bulb Temperature for Compressor Operation

This numeric field defines the minimum outdoor air dry-bulb temperature where the heating coil compressor turns off. The temperature for this input field must be greater than or equal to –20 C. If this input field is left blank, the default value is -8 C.

#### Field: Outdoor Dry-Bulb Temperature to Turn On Compressor

This numeric field defines the outdoor air dry-bulb temperature when the compressor is automatically turned back on following an automatic shut off because of low outdoor temperature. This field is only used for the calculation heating seasonal performance factor (HSPF) of heating coil. If this field is not provided, outdoor bin temperature is always considered to be greater than this temperature and ‘Minimum Outdoor dry-bulb Temperature for Compressor Operation’ field described above.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Defrost Operation

This numeric field defines the outdoor air dry-bulb temperature above which outdoor coil defrosting is disabled. The temperature for this input field must be greater than or equal to 0 C and less than or equal to 7.22 C. If this input field is left blank, the default value is 5 C.

#### Field: Crankcase Heater Capacity

This numeric field defines the crankcase heater capacity in Watts. When the outdoor air dry-bulb temperature is below the value specified in the input field “Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation” (described below), the crankcase heater is enabled during the time that the compressor is not running. If this heating coil is used as part of an air-to-air heat pump (Ref. AirLoopHVAC:UnitaryHeatPump:AirToAir or ZoneHVAC:PackagedTerminalHeatPump), the crankcase heater defined for this DX heating coil is enabled during the time that the compressor is not running for either heating or cooling (and the crankcase heater power defined in the DX cooling coil object is disregarded in this case). The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0. To simulate a unit without a crankcase heater, enter a value of 0.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation

This numeric field defines the outdoor air dry-bulb temperature above which the compressor’s crankcase heater is disabled. The value for this input field must be greater than or equal to 0.0 C. If this input field is left blank, the default value is 10 C.

#### Field: Defrost Strategy

This alpha field has two choices: reverse-cycle or resistive. If the reverse-cycle strategy is selected, the heating cycle is reversed periodically to provide heat to melt frost accumulated on the outdoor coil. If a resistive defrost strategy is selected, the frost is melted using an electric resistance heater. If this input field is left blank, the default defrost strategy is reverse-cycle.

#### Field: Defrost Control

This alpha field has two choices: timed or on-demand. If timed control is selected, the defrost time period is calculated based on a fixed value or compressor runtime whether or not frost has actually accumulated. For timed defrost control, the fractional amount of time the unit is in defrost is entered in the input field “Defrost Time Period Fraction” described below. If on-demand defrost control is selected, the defrost time period is calculated based on outdoor weather (humidity ratio) conditions. Regardless of which defrost control is selected, defrost does not occur above the user specified outdoor temperature entered in the input field “Maximum Outdoor Dry-bulb Temperature for Defrost Operation” described above. If this input field is left blank, the default defrost control is timed.

#### Field: Defrost Time Period Fraction

This numeric field defines the fraction of compressor runtime when the defrost cycle is active, and only applies to “timed” defrost (see Defrost Control input field above). For example, if the defrost cycle is active for 3.5 minutes for every 60 minutes of compressor runtime, then the user should enter 3.5/60 = 0.058333. The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0.058333.

#### Field: Resistive Defrost Heater Capacity

This numeric field defines the capacity of the resistive defrost heating element in Watts. This input field is used only when the selected defrost strategy is ‘resistive’ (see input field “Defrost Strategy” above). The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0.

#### Field: Region Number

This optional numeric field defines the region number which is used to calculate HSPF of heating coil. The value for this input field must be between 1 and 6. If this input field is left blank, the default value is 4.

#### Field: Evaporator Air Inlet Node Name

This optional alpha field specifies the outdoor air node name used to define the conditions of the air entering the outdoor evaporator. If this field is left blank, the outdoor air temperature entering the evaporator is taken directly from the weather data. If this field is not blank, the node name specified must also be specified in an OutdoorAir:Node object where the height of the node is taken into consideration when calculating outdoor air temperature from the weather data. Alternately, the node name may be specified in an OutdoorAir:NodeList object where the outdoor air temperature is taken directly from the weather data.

#### Field: Zone Name for Evaporator Placement

This input field is name of a conditioned or unconditioned zone where the secondary coil (evaporator) of a heat pump is installed. This is an optional input field specified only when user desires to extract heat from the zone via secondary coil. Heat extracted is modeled as internal gain. If the primary DX system is a heat pump, then the zone name should be the same as the zone name specified for placing the secondary cooling DX coil.

#### Field: Secondary Coil Air Flow Rate

This input value is the secondary coil (evaporator) air flow rate when the heat pump is working in heating mode or the secondary coil (condenser) air flow rate when the heat pump is working in cooling mode. This input field is auto-sizable.

#### Field: Secondary Coil Fan Flow Scaling Factor

This input field is scaling factor for autosizing the secondary DX coil fan flow rate. The secondary air flow rate is determined by multiplying the primary DX coil rated air flow rate by the fan flow scaling factor. Default value is 1.25. If the secondary coil fan flow rate is not autosized, then the secondary coil fan flow scaling factor is set to 1.0.

#### Field: Nominal Sensible Heat Ratio of Secondary Coil

This input value is the nominal sensible heat ratio used to split the heat extracted by a secondary DX coil (evaporator) of a heat pump into sensible and latent components. This is an optional input field. If this input field is left blank, then pure sensible internal heat gain is assumed, i.e., sensible heat ratio of 1.0.

#### Field: Sensible Heat Ratio Modifier Function of Temperature Curve Name

This input field is name of sensible heat ratio modifier biquadratic curve. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary zone air node wet-bulb temperature and the heating DX coil entering air dry-bulb temperature. This is an optional input field. If this input field is left blank, then the nominal sensible heat ratio modifier curve value for temperature is set to 1.0.

#### Field: Sensible Heat Ratio Modifier Function of Flow Fraction Curve Name

This input field is name of sensible heat ratio modifier curve as function of secondary air flow fraction. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary coil air flow fraction. This is an optional input field. If this input field is left blank, then the sensible heat ratio modifier curve value for flow fraction is set to 1.0.

Following is an example input for the object.

Coil:Heating:DX:SingleSpeed,

Heat Pump DX Heating Coil 1, !Name of heating coil

FanAndCoilAvailSched, !Heating coil schedule

35000, !Nominal capacity of the heating coil

2.75, !rated heating COP

1.7, !rated air flow rate (m3/s)

, !rated evaporator fan power per volume flow rate (m3/s)

Heating Coil Air Inlet Node, !heating coil air side inlet node

SuppHeating Coil Air Inlet Node, !Heating coil air side outlet node

HPACHeatCapFT, ! heating cap modifier curve (temperature, C)

HPACHeatCapFFF, ! heating cap modifier curve (flow fraction)

HPACHeatEIRFT, ! energy input ratio modifier curve (temperature, C)

HPACHeatEIRFFF, ! energy input ratio modifier curve (flow fraction)

HPACCOOLPLFFPLR, ! part load fraction modifier curve (function of part load ratio)

, ! defrost EIR modifier curve (temp, C) not required for resistive defrost

-5.0, ! minimum OAT for compressor operation (C)

, ! outdoor dry-bulb temperature to turn on compressor (C)

5.0, ! maximum outdoor dry-bulb temp for defrost operation (C)

200.0, ! Crankcase heater capacity (W)

10.0, ! Maximum outdoor temp for crankcase heater operation (C)

Resistive, ! Defrost strategy (resistive or reverse-cycle)

Timed, ! Defrost control (timed or on-demand)

0.166667, ! Defrost time period fraction (used for timed defrost control only)

20000;! Resistive defrost heater capacity (used for resistive defrost strategy only)

### DX Heating Coil Outputs

HVAC,Average,Heating Coil Total Heating Rate [W]

HVAC,Sum,Heating Coil Total Heating Energy [J]

HVAC,Average,Heating Coil Electric Power[W]

HVAC,Sum,Heating Coil Electric Energy [J]

HVAC,Average,Heating Coil Defrost Electric Power[W]

HVAC,Sum,Heating Coil Defrost Electric Energy [J]

HVAC,Average,Heating Coil Crankcase Heater Electric Power[W]

HVAC,Sum,Heating Coil Crankcase Heater Electric Energy [J]

HVAC,Average,Heating Coil Runtime Fraction []

#### Heating Coil Total Heating Rate [W]

This field is the total heating rate output of the DX coil in Watts. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil.

#### Heating Coil Total Heating Energy [J]

This is the total heating output of the DX coil in Joules over the timestep being reported. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil. This output is also added to a meter with Resource Type = EnergyTransfer, End Use Key = CoolingCoils, Group Key = System (ref. Output:Meter object).

#### Heating Coil Electric Power [W]

This output is the electricity consumption rate of the DX coil compressor and outdoor fan(s) in Watts. This rate is applicable when the unit is providing heating to the conditioned zone(s), and excludes periods when the unit is in reverse-cycle defrost mode.

#### Heating Coil Electric Energy [J]

This is the electricity consumption of the DX coil compressor and condenser fan(s) in Joules for the timestep being reported. This consumption is applicable when the unit is providing heating to the conditioned zone(s), and excludes periods when the unit is in reverse-cycle defrost mode. This output is also added to a meter with Resource Type = Electricity, End Use Key = Cooling, Group Key = System (ref. Output:Meter object).

#### Heating Coil Defrost Electric Power [W]

This is the electricity consumption rate of the DX coil unit in Watts when the unit is in defrost mode (reverse-cycle or resistive).

#### Heating Coil Defrost Electric Energy [J]

This is the electricity consumption of the DX coil unit in Joules for the timestep being reported. This consumption is applicable when the unit is in defrost mode (reverse-cycle or resistive).

#### Heating Coil Crankcase Heater Electric Power [W]

This is the average electricity consumption rate of the DX coil compressor’s crankcase heater in Watts for the timestep being reported.

#### Heating Coil Crankcase Heater Electric Energy [J]

This is the electricity consumption of the DX coil compressor’s crankcase heater in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Miscellaneous, Group Key = System (ref. Output:Meter object).

#### Heating Coil Runtime Fraction []

This is the runtime fraction of the DX heating coil compressor and outdoor fan(s) for the timestep being reported.

### Coil:Heating:DX:MultiSpeed

This component models a DX heating unit with multiple discrete levels of heating capacity. Currently, this heating coil can only be referenced by a AirLoopHVAC:UnitaryHeatPump:AirToAir:MultiSpeed compound object. The multispeed DX heating coil can have from two to four operating speeds. When the coil operates at Speed 1 (the lowest speed), its performance is very similar to the Coil:Heating:DX:SingleSpeed object where the impacts of part-load ratio can be included. When the coil operates at higher speeds (above Speed 1), the linear approximation methodology is applied. The coil outputs at two consecutive speeds are linearly interpolated to meet the required heating capacity during an HVAC system timestep. When the coil performs above the lowest speed, the user can choose if they want to include part-load ratio impacts at the higher speeds.

The multispeed unit is described by specifying the performance at different operating speeds. Each speed has its own set of input specifications: full load capacity, COP and air flow rate at rated conditions, along with modifier curves to determine performance when actual operating conditions are different from the rated conditions.

The coil operates to meet the sensible capacity being requested. When this requested capacity is above the sensible capacity of the highest operating speed, the coil runs continuously at the highest speed. When the requested capacity is between the sensible capacities of two consecutive speeds, the unit will operate a portion of the time at each speed to meet the request. When the requested capacity is less than the low speed (Speed 1) capacity, the unit will cycle on/off as needed.

The next input defines the minimum outdoor dry-bulb temperature where the compressor will operate. The followed two inputs are related to crankcase heater operation: capacity and maximum outdoor dry-bulb temperature for crankcase heater operation. The next six inputs cover defrost operation: defrost EIR modifier curve, the maximum outdoor dry-bulb temperature for defrost operation, the type of defrost strategy (reverse-cycle or resistive), defrost control (timed or on-demand), the fractional defrost time period (timed defrost control only), and the resistive defrost heater capacity if a resistive defrost strategy is selected. The activation of defrost is dependent on outdoor conditions. The capacity reduction and energy use modification are independent of speed. The defrost EIR modifier is described below:

The defrost energy input ratio (EIR) modifier curve (function of temperature) is a bi-quadratic curve with two independent variables: outdoor air dry-bulb temperature and the heating coil entering air wet-bulb temperature. The output of this curve is multiplied by the heating coil capacity, the fractional defrost time period and the runtime fraction of the heating coil to give the defrost power at the specific temperatures at which the coil is operating. This curve is only required when a reverse-cycle defrost strategy is specified.

The next input allows the user to choose whether to apply the part load fraction correlation to speeds greater than 1 or not. The following input is the type of fuel.

Then the number of speed for heating is entered. The rest of inputs are speed dependent. Each set of data consists of rated heating capacity, rated COP, and the rated air volume flow rate. These three inputs determine the coil performance at the rating point (outdoor air dry-bulb temperature of 8.33°C, outdoor air wet-bulb temperature of 6.11°C, coil entering air dry-bulb temperature of 21.11°C, coil entering air wet-bulb temperature of 15.55°C). The rated air volume flow rate should be between .00004027 m3/s and .00006041 m3/s per watt of rated total heating capacity. The rated waste heat fraction is needed to calculate how much waste heat is available at the rated conditions. In addition, up to 6 modifier curves are required per speed.

1. The total heating capacity modifier curve (function of temperature) can be a function of both the outdoor and indoor air dry-bulb temperature or only the outdoor air dry-bulb temperature. User has the choice of a bi-quadratic curve with two independent variables or a quadratic curve as well as a cubic curve with a single independent variable. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated total heating capacity to give the total heating capacity at specific temperature operating conditions (i.e., at an outdoor or indoor air temperature different from the rating point temperature).
2. The total heating capacity modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total heating capacity and the total heating capacity modifier curve (function of temperature) to give the total heating capacity at the specific temperature and air flow conditions at which the coil is operating.
3. The energy input ratio (EIR) modifier curve (function of temperature) can be a function of both the outdoor and indoor air dry-bulb temperature or only the outdoor air dry-bulb temperature. User has the choice of a bi-quadratic curve with two independent variables or a quadratic curve as well as a cubic curve with a single independent variable. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated EIR (inverse of the rated COP) to give the EIR at specific temperature operating conditions (i.e., at an outdoor or indoor air temperature different from the rating point temperature).
4. The energy input ratio (EIR) modifier curve (function of flow fraction) is a quadratic or cubic curve with the independent variable being the ratio of the actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated EIR (inverse of the rated COP) and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the coil is operating.
5. The part load fraction correlation (function of part load ratio) is a quadratic or cubic curve with the independent variable being part load ratio (sensible heating load / steady-state heating capacity). The output of this curve is used in combination with the rated EIR and EIR modifier curves to give the “effective” EIR for a given simulation timestep. The part load fraction correlation accounts for efficiency losses due to compressor cycling.
6. The waste heat modifier curve (function of temperature) is a bi-quadratic curve with two independent variables: outdoor air dry-bulb temperature and the heating coil entering air dry-bulb temperature. The output of this curve is multiplied by the heating input energy, the waste heat fraction of heat input to give the recoverable waste heat.

The curves are simply specified by name. Curve inputs are described in the curve manager section of this document (ref. Performance Curves).

#### Field: Name

This alpha field defines a unique user-assigned name for an instance of a multispeed DX heating coil. Any reference to this DX heating coil by another object will use this name. The only allowed parent is AirLoopHVAC:UnitaryHeatPump:AirToAir:MultiSpeed.

#### Field: Availability Schedule Name

This alpha field defines the name of the schedule (ref: Schedule) that denotes whether the multispeed DX heating coil can run during a given time period. A schedule value greater than 0 (usually 1 is used) indicates that the unit can be on during the time period. A value less than or equal to 0 (usually 0 is used) denotes that the unit must be off for the time period. If this field is blank, the schedule has values of 1 for all time periods.

#### Field: Air Inlet Node name

This alpha field defines the name of the HVAC system node from which the DX heating coil draws its inlet air.

#### Field: Air Outlet Node Name

This alpha field defines the name of the HVAC system node to which the DX heating coil sends its outlet air.

#### Field: Minimum Outdoor Dry-Bulb Temperature for Compressor Operation

This numeric field defines the minimum outdoor air dry-bulb temperature where the heating coil compressor turns off. The temperature for this input field must be greater than or equal to –20°C. If this input field is left blank, the default value is -8°C.

#### Field: Crankcase Heater Capacity

This numeric field defines the crankcase heater capacity in Watts. When the outdoor air dry-bulb temperature is below the value specified in the input field “Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation” (described below), the crankcase heater is enabled during the time that the compressor is not running. The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0. To simulate a unit without a crankcase heater, enter a value of 0.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation

This numeric field defines the outdoor air dry-bulb temperature above which the compressor’s crankcase heater is disabled. The value for this input field must be greater than or equal to 0.0°C. If this input field is left blank, the default value is 10°C.

#### Field: Defrost Energy Input Ratio Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic performance curve (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) during reverse-cycle defrost periods as a function of the outdoor air dry-bulb temperature and the wet-bulb temperature of the air entering the indoor coil. The EIR is the inverse of the COP. The output of this curve is multiplied by the coil capacity, the fractional defrost time period and the runtime fraction of the heating coil to give the defrost power at the specific temperatures at which the indoor and outdoor coils are operating. This curve is only required when a reverse-cycle defrost strategy is selected. The curve is normalized to a value of 1.0 at the rating point conditions.

#### Field: Maximum Outdoor Dry-Bulb Temperature for Defrost Operation

This numeric field defines the outdoor air dry-bulb temperature above which outdoor coil defrosting is disabled. The temperature for this input field must be greater than or equal to 0°C and less than or equal to 7.22°C. If this input field is left blank, the default value is 5°C.

#### Field: Defrost Strategy

This alpha field has two choices: reverse-cycle or resistive. If the reverse-cycle strategy is selected, the heating cycle is reversed periodically to provide heat to melt frost accumulated on the outdoor coil. If a resistive defrost strategy is selected, the frost is melted using an electric resistance heater. If this input field is left blank, the default defrost strategy is reverse-cycle.

#### Field: Defrost Control

This alpha field has two choices: timed or on-demand. If timed control is selected, the defrost time period is calculated based on a fixed value or compressor runtime whether or not frost has actually accumulated. For timed defrost control, the fractional amount of time the unit is in defrost is entered in the input field “Defrost Time Period Fraction” described below. If on-demand defrost control is selected, the defrost time period is calculated based on outdoor weather (humidity ratio) conditions. Regardless of which defrost control is selected, defrost does not occur above the user specified outdoor temperature entered in the input field “Maximum Outdoor Dry-bulb Temperature for Defrost Operation” described above. If this input field is left blank, the default defrost control is timed.

#### Field: Defrost Time Period Fraction

This numeric field defines the fraction of compressor runtime when the defrost cycle is active, and only applies to “timed” defrost (see Defrost Control input field above). For example, if the defrost cycle is active for 3.5 minutes for every 60 minutes of compressor runtime, then the user should enter 3.5/60 = 0.058333. The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0.058333.

#### Field: Resistive Defrost Heater Capacity

This numeric field defines the capacity of the resistive defrost heating element in Watts. This input field is used only when the selected defrost strategy is ‘resistive’ (see input field “Defrost Strategy” above). The value for this input field must be greater than or equal to 0. If this input field is left blank, the default value is 0.

#### Field: Apply Part Load Fraction to Speeds Greater than 1

This field determines whether part-load impacts on coil energy use are applied when the coil is operating at speeds greater than speed 1. The allowed choices are Yes or No, with the default being No if this field is left blank. Other input fields in this object allow the user to specify a part-load fraction correlation for each speed to account for compressor start up losses (cycle on/off). For the case of a single multi-speed compressor, the part load losses may only be significant when the compressor cycles between speed 1 and off, but the losses may be extremely small when the compressor operates between speed 1 and speed 2 (or between speeds 2 and 3, etc.). In this case, the user may chose to specify **No** for this input field to neglect part-load impacts on energy use at higher operating speeds. If part-load impacts on coil energy use are thought to be significant (e.g., interwined cooling coil with multiple compressors feeding individual refrigerant circuits), then the user may chose to specify **Yes** and the part-load fraction correlations specified for speeds 2 through 4 will be applied as appropriate. The selection for this input field does not affect part-load impacts when the compressor cycles between speed 1 and off (i.e., the part-load fraction correlation for speed 1 is always applied).

#### Field: Fuel Type

This alpha field determines the type of fuel that the chiller uses. This field has seven choices: Electricity, NaturalGas, PropaneGas, Coal, Diesel, Gasoline, FuelOil#1, FuelOil#2, OtherFuel1 and OtherFuel2. The default is NaturalGas.

#### Field: Number of Speeds

This field specifies the number of sets of data being entered for rated specifications, performance curves, and waste heat specifications for each cooling speed. The rated specifications consist of rated capacity, rated COP, and rated air flow rate. The performance curves consist of a total capacity modifier curve as a function of temperature, total capacity modifier curve as a function of flow fraction, energy input ratio modifier curve as a function of temperature, energy input ratio modifier curve as a function of flow fraction, and part load fraction correlation as a function of part load ratio. The waste heat specifications include the fraction of energy input to the heating coil at the fully loaded and rated conditions, and a temperature modifier. The minimum number of speeds for heating is 2 and the maximum number is 4. The number of speeds should be the same as the number of speeds for heating defined in its parent object (AirLoopHVAC:UnitaryHeatPump:AirToAir:MultiSpeed). The first set of performance inputs is for Speed 1 and should be for low speed, and the last set of performance inputs should be for high speed. For example, if only three heating speeds are defined, the first set should be for low speed (Speed 1), the second set should be for medium speed (Speed 2), and the third set should be for high speed (Speed 3). In this example, any performance inputs for Speed 4 would be neglected (since this input field specifies that the coil only has three heating speeds).

#### Field Group: rated specification, performance curves, and waste heat data

The performance for each heating speed must be specified as shown below. All inputs for Speed 1 are required first, followed by the inputs for Speed 2, Speed 3 and Speed 4.

#### Field: Speed <x> Rated Total Heating Capacity

This numeric field defines the total, full load heating capacity in watts of the DX coil unit at rated conditions for Speed <x> operation (outdoor air dry-bulb temperature of 8.33°C, outdoor air wet-bulb temperature of 6.11°C, heating coil entering air dry-bulb temperature of 21.11°C, heating coil entering air wet-bulb temperature of 15.55°C, and a heating coil air flow rate defined by field “Rated Air Volume Flow Rate, Speed <x>” below). The value entered here must be greater than 0. Capacity should not include supply air fan heat.

#### Field: Speed <x> Rated COP

This numeric field defines the coefficient of performance (COP=heating power output in watts divided by electrical power input in watts) of the DX heating coil unit at rated conditions for Speed <x> operation (outdoor air dry-bulb temperature of 8.33°C, outdoor air wet-bulb temperature of 6.11°C, coil entering air dry-bulb temperature of 21.11°C, coil entering air wet-bulb temperature of 15.55°C, and a heating coil air flow rate defined by field “Speed <x> Rated Air Flow Rate” below). The value entered here must be greater than 0. The input power includes power for the compressor(s) and outdoor fan(s) but does not include the power consumption of the indoor supply air fan. The heating power output is the value entered above in the field “Rated Total Heating Capacity”.

#### Field: Speed <x> Rated Air Flow Rate

This numeric field defines the volume air flow rate, in m3 per second, across the DX heating coil at rated conditions for Speed <x> operation. The value entered here must be greater than 0. The rated air volume flow rate should be between 0.00004027 m3/s and 0.00006041 m3/s per watt of rated total heating capacity. The rated total heating capacity and rated COP should be performance information for the unit with outdoor air dry-bulb temperature of 8.33°C, outdoor air wet-bulb temperature of 6.11°C, heating coil entering air dry-bulb temperature of 21.11°C, heating coil entering air wet-bulb temperature of 15.55°C, and the rated air volume flow rate defined here.

#### Field: Speed <x> Total Heating Capacity Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic, quadratic or cubic performance curve for Speed <x> (ref: Performance Curves) that parameterizes the variation of the total heating capacity as a function of the both the indoor and outdoor air dry-bulb temperature or just the outdoor air dry-bulb temperature depending on the type of curve selected. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The output of this curve is multiplied by the rated total heating capacity to give the total heating capacity at specific temperature operating conditions (i.e., at an indoor air dry-bulb temperature or outdoor air dry-bulb temperature different from the rating point temperature). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Speed <x> Total Heating Capacity Function of Flow Fraction Curve Name

This alpha field defines the name of a quadratic or cubic performance curve for Speed <x> (ref: Performance Curves) that parameterizes the variation of total heating capacity as a function of the ratio of actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The output of this curve is multiplied by the rated total heating capacity and the total heating capacity modifier curve (function of temperature) to give the total heating capacity at the specific temperature and air flow conditions at which the coil is operating. The curve is normalized to have the value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Speed <x> Energy Input Ratio Function of Temperature Curve Name

This alpha field defines the name of a bi-quadratic, quadratic or cubic performance curve for Speed <x> (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the both the indoor and outdoor air dry-bulb temperature or just the outdoor air dry-bulb temperature depending on the type of curve selected. The bi-quadratic curve is recommended if sufficient manufacturer data is available as it provides sensitivity to the indoor air dry-bulb temperature and a more realistic output. The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR (inverse of rated COP) to give the EIR at specific temperature operating conditions (i.e., at an indoor air dry-bulb temperature or outdoor air dry-bulb temperature different from the rating point temperature). The curve is normalized to have the value of 1.0 at the rating point.

#### Field: Speed <x> Energy Input Ratio Function of Flow Fraction Curve Name

This alpha field defines the name of a quadratic or cubic performance curve for Speed <x> (ref: Performance Curves) that parameterizes the variation of the energy input ratio (EIR) as a function of the ratio of actual air flow rate across the heating coil to the rated air flow rate (i.e., fraction of full load flow). The EIR is the inverse of the COP. The output of this curve is multiplied by the rated EIR and the EIR modifier curve (function of temperature) to give the EIR at the specific temperature and air flow conditions at which the coil is operating. This curve is normalized to a value of 1.0 when the actual air flow rate equals the rated air flow rate.

#### Field: Speed <x>Part Load Fraction Correlation Curve Name

This alpha field defines the name of a quadratic or cubic performance curve for Speed <x> (Ref: Performance Curves) that parameterizes the variation of electrical power input to the DX unit as a function of the part load ratio (PLR, sensible cooling load/steady-state sensible cooling capacity). The product of the rated EIR and EIR modifier curves is divided by the output of this curve to give the “effective” EIR for a given simulation timestep. The part load fraction (PLF) correlation accounts for efficiency losses due to compressor cycling.

The part load fraction correlation should be normalized to a value of 1.0 when the part load ratio equals 1.0 (i.e., no efficiency losses when the compressor(s) run continuously for the simulation timestep). For PLR values between 0 and 1 (0 <= PLR < 1), the following rules apply:

PLF >= 0.7 and PLF >= PLR

If PLF < 0.7 a warning message is issued, the program resets the PLF value to 0.7, and the simulation proceeds. The runtime fraction of the coil is defined as PLR/PLF. If PLF < PLR, then a warning message is issued and the runtime fraction of the coil is limited to 1.0.

A typical part load fraction correlation for a conventional DX heating coil (Speed <x>) would be:

PLF = 0.85 + 0.15(PLR)

If the user wishes to model no efficiency degradation due to compressor cycling, the part load fraction correlation should be defined as follows:

PLF = 1.0 + 0.0(PLR)

#### Field: Speed <x> Rated Waste Heat Fraction of Power Input

The fraction of heat input to heating that is available as recoverable waste heat at full load and rated conditions for Speed <x> operation.

#### Field: Speed <x> Waste Heat Function of Temperature Curve Name

The name of a bi-quadratic performance curve (ref: Performance Curves) that parameterizes the variation of the waste heat recovery as a function of outdoor dry-bulb temperature and the entering coil dry-bulb temperature for Speed <x>. The output of this curve is multiplied by the rated recoverable waste heat at specific temperature operating conditions (i.e., at temperatures different from the rating point). The curve is normalized to a value of 1.0 at the rating point. When the fuel type is electricity, the field is either left blank or ignored by the program.

#### Field: Zone Name for Evaporator Placement

This input field is name of a conditioned or unconditioned zone where the secondary coil (evaporator) of a heat pump is installed. This is an optional input field specified only when user desires to extract heat from the zone via secondary coil. Heat extracted is modeled as internal gain. If the primary DX system is a heat pump, then the zone name should be the same as the zone name specified for placing the secondary cooling DX coil.

#### Field: Speed <x> Secondary Coil Air Flow Rate

This input value is the secondary coil (evaporator) air flow rate when the heat pump is working in heating mode or the secondary coil (condenser) air flow rate when the heat pump is working in cooling mode. This input field is auto-sizable.

#### Field: Speed <x> Secondary Coil Fan Flow Scaling Factor

This input field is scaling factor for autosizing the secondary DX coil fan flow rate. The secondary air flow rate is determined by multiplying the primary DX coil rated air flow rate by the fan flow scaling factor. Default value is 1.25. If the secondary coil fan flow rate is not autosized, then the secondary coil fan flow scaling factor is set to 1.0.

#### Field: Speed <x> Nominal Sensible Heat Ratio of Secondary Coil

This input value is the nominal sensible heat ratio used to split the heat extracted by a secondary DX coil (evaporator) of a heat pump into sensible and latent components. This is an optional input field. If this input field is left blank, then pure sensible internal heat gain is assumed, i.e., sensible heat ratio of 1.0.

#### Field: Speed <x> Sensible Heat Ratio Modifier Function of Temperature Curve Name

This input field is name of sensible heat ratio modifier biquadratic curve. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary zone air node wet-bulb temperature and the heating DX coil entering air dry-bulb temperature. This is an optional input field. If this input field is left blank, then the nominal sensible heat ratio modifier curve value for temperature is set to 1.0.

#### Field: Speed <x> Sensible Heat Ratio Modifier Function of Flow Fraction Curve Name

This input field is name of sensible heat ratio modifier curve as function of secondary air flow fraction. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary coil air flow fraction. This is an optional input field. If this input field is left blank, then the sensible heat ratio modifier curve value for flow fraction is set to 1.0.

Following is an example input for a multi-speed heating DX coil.

COIL:Heating:DX:MultiSpeed,

Heat Pump DX Heating Coil 1, !- Name of heat pump heating coil

FanAndCoilAvailSched, !- Availability Schedule

Heating Coil Air Inlet Node, !- Coil Air Inlet Node

SuppHeating Coil Air Inlet Node, !- Coil Air Outlet Node

-8.0, !- Minimum Outdoor Dry-bulb Temperature for Compressor Operation {C}

200.0, !- Crankcase Heater Capacity {W}

10.0, !- Maximum Outdoor Dry-bulb Temperature for Crankcase Heater Operation {C}

HPACDefrostCAPFT, !- Defrost energy input ratio modifier curve (temperature)

7.22, !- Maximum Outdoor Dry-bulb Temperature for Defrost Operation

reverse-cycle, !- Defrost Strategy

timed, !- Defrost Control

0.058333, !- Defrost Time Period Fraction

2000.0, !- Resistive Defrost Heater Capacity {W}

No, !- Apply Part Load Fraction to Speeds greater than 1

NaturalGas, !- Fuel type

4, !- Number of speeds

7500, !- Rated Total Heating Capacity, Speed 1 {W}

2.75, !- Rated COP, Speed 1

0.45, !- Rated Air Volume Flow Rate, Speed 1 {m3/s}

HPACHeatCapFT Speed 1, !- Total Heating Capacity Modifier Curve, Speed 1 (temperature)

HPACHeatCapFF Speed 1, !- Total Heating capacity modifier curve, Speed 1 (flow fraction)

HPACHeatEIRFT Speed 1, !- Energy input ratio modifier curve, Speed 1 (temperature)

HPACHeatEIRFF Speed 1, !- Energy input ratio modifier curve, Speed 1 (flow fraction)

HPACHeatPLFFPLR Speed 1, !- Part load fraction correlation, Speed 1 (part load ratio)

0.2, !- Rated waste heat fraction of power input, Speed 1

HAPCHeatWHFT Speed 1, !- Waste heat modifier curve, Speed 1 (temperature)

17500, !- Rated Total Heating Capacity, Speed 2 {W}

2.75, !- Rated COP, Speed 2

0.85, !- Rated Air Volume Flow Rate, Speed 2 {m3/s}

HPACHeatCapFT Speed 2, !- Total Heating Capacity Modifier Curve, Speed 2 (temperature)

HPACHeatCapFF Speed 2, !- Total Heating capacity modifier curve, Speed 2 (flow fraction)

HPACHeatEIRFT Speed 2, !- Energy input ratio modifier curve, Speed 2 (temperature)

HPACHeatEIRFF Speed 2, !- Energy input ratio modifier curve, Speed 2 (flow fraction)

HPACHeatPLFFPLR Speed 2, !- Part load fraction correlation, Speed 2 (part load ratio)

0.2, !- Rated waste heat fraction of power input, Speed 2

HAPCHeatWHFT Speed 2, !- Waste heat modifier curve, Speed 2 (temperature)

25500, !- Rated Total Heating Capacity, Speed 3 {W}

2.75, !- Rated COP, Speed 3

1.25, !- Rated Air Volume Flow Rate, Speed 3 {m3/s}

HPACHeatCapFT Speed 3, !- Total Heating Capacity Modifier Curve, Speed 3 (temperature)

HPACHeatCapFF Speed 3, !- Total Heating capacity modifier curve, Speed 3 (flow fraction)

HPACHeatEIRFT Speed 3, !- Energy input ratio modifier curve, Speed 3 (temperature)

HPACHeatEIRFF Speed 3, !- Energy input ratio modifier curve, Speed 3 (flow fraction)

HPACHeatPLFFPLR Speed 3, !- Part load fraction correlation, Speed 3 (part load ratio)

0.2, !- Rated waste heat fraction of power input, Speed 3

HAPCHeatWHFT Speed 3, !- Waste heat modifier curve, Speed 3 (temperature)

35500, !- Rated Total Heating Capacity, Speed 4 {W}

2.75, !- Rated COP, Speed 4

1.75, !- Rated Air Volume Flow Rate, Speed 4 {m3/s}

HPACHeatCapFT Speed 4, !- Total Heating Capacity Modifier Curve, Speed 4 (temperature)

HPACHeatCapFF Speed 4, !- Total Heating capacity modifier curve, Speed 4 (flow fraction)

HPACHeatEIRFT Speed 4, !- Energy input ratio modifier curve, Speed 4 (temperature)

HPACHeatEIRFF Speed 4, !- Energy input ratio modifier curve, Speed 4 (flow fraction)

HPACHeatPLFFPLR Speed 4, !- Part load fraction correlation, Speed 4 (part load ratio)

0.2, !- Rated waste heat fraction of power input, Speed 4

HAPCHeatWHFT Speed 4; !- Waste heat modifier curve, Speed 4 (temperature)

### MultiSpeed DX Heating Coil Outputs

HVAC,Average,Heating Coil Total Heating Rate [W]

HVAC,Sum,Heating Coil Total Heating Energy [J]

HVAC,Average,Heating Coil Electric Power[W]

HVAC,Sum,Heating Coil Electric Energy [J]

HVAC,Average,Heating Coil Defrost Electric Power[W]

HVAC,Sum,Heating Coil Defrost Electric Energy [J]

HVAC,Average,Heating Coil Defrost Gas Rate [W]

HVAC,Sum,Heating Coil Defrost Gas Energy [J]

HVAC,Average,Heating Coil Crankcase Heater Electric Power[W]

HVAC,Sum,Heating Coil Crankcase Heater Electric Energy [J]

HVAC,Average,Heating Coil Runtime Fraction []

If Fuel Type is not Electricity:

HVAC,Average, Heating Coil <Fuel Type> Rate [W]

HVAC,Sum, Heating Coil <Fuel Type> Energy [J]

#### Heating Coil Total Heating Rate [W]

This field is the total heating rate output of the DX coil in Watts. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil.

#### Heating Coil Total Heating Energy [J]

This is the total heating output of the DX coil in Joules over the timestep being reported. This is determined by the coil inlet and outlet air conditions and the air mass flow rate through the coil. This output is also added to a meter with Resource Type = EnergyTransfer, End Use Key = HeatingCoil, Group Key = System (ref. Output:Meter object).

#### Heating Coil Electric Power [W]

This output variable is the input fuel type power for the heating coil in the unit of Watts, averaged during the report period. If Fuel Type is not Electricity, the value is zero.

#### Cooling Coil Electric Energy [J]

This output variable is the input fuel type consumption for the multispeed heating coil in the unit of Joules, summed during the report period. This output is also added to a meter with Resource Type = Electricity, End Use Key = Heating, Group Key = System (ref. Output:Meter object). If Fuel Type is not Electricity, the value is zero.

#### Heating Coil Defrost Electric Power [W]

This is the electricity consumption rate of the DX coil unit in Watts when the unit is in defrost mode (reverse-cycle or resistive). The variable is available when the defrost mode is resistive or the fuel type is electricity.

#### Heating Coil Defrost Electric Energy [J]

This is the electricity consumption of the DX coil unit in Joules for the timestep being reported. This consumption is applicable when the unit is in defrost mode (reverse-cycle or resistive). The variable is available when the defrost mode is resistive or the fuel type is electricity.

#### Heating Coil Defrost <Fuel Type> Rate [W]

This is the fuel consumption rate of the DX coil unit in Watts when the unit is in defrost mode (reverse-cycle). The variable is available when the defrost mode is reverse-cycle and the fuel type is non-electricity.

#### Heating Coil Defrost <Fuel Type> Energy [J]

This is the fuel consumption of the DX coil unit in Joules for the timestep being reported. This consumption is applicable when the unit is in defrost mode (reverse-cycle). The variable is available when the defrost mode is reverse-cycle and the fuel type is non-electricity.

#### Heating Coil Crankcase Heater Electric Power [W]

This is the average electricity consumption rate of the DX coil compressor’s crankcase heater in Watts for the timestep being reported. When a companion cooling coil exits, the crankcase heater power of the companion cool coil is alos reported in this variable.

#### Heating Coil Crankcase Heater Electric Energy [J]

This is the electricity consumption of the DX coil compressor’s crankcase heater in Joules for the timestep being reported. This output is also added to a meter with Resource Type = Electricity, End Use Key = Heating, Group Key = System (ref. Output:Meter object). When a companion cooling coil exits, the crankcase heater power of the companion cool coil is alos reported in this variable.

#### Heating Coil Runtime Fraction []

This is the runtime fraction of the DX heating coil compressor and outdoor fan(s) for the timestep being reported. When the heating speed is above 1, this output is the run time fraction for the higher speed.

#### Heating Coil <Fuel Type> Rate [W]

This output variable is the input fuel type power for the heating coil in the unit of Watts, averaged during the report period. The electric power is excluded. If Fuel Type is Electricity, this output variable is not reported.

#### Cooling Coil <Fuel Type> Energy [J]

This output variable is the input fuel type consumption for the multispeed heating coil in the unit of Joules, summed during the report period. The electric consumption is excluded. This output is also added to a meter with Resource Type = <Fuel Type>, End Use Key = Heating, Group Key = System (ref. Output:Meter object). If Fuel Type is Electricity, this output variable is not reported.

Note: The Fuel Type defined in the above two output variables depends on the input in the fuel type filed. In addition to Electricity, Valid fuel types are NaturalGas, Propane, FuelOil#1, FuelOil#2, Coal, Diesel, Gasoline, OtherFuel1 and OtherFuel2.

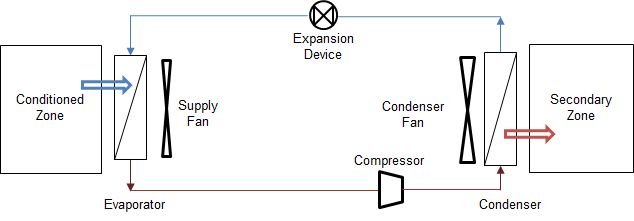
### Coil:Heating:DX:VariableSpeed

<<Snipp>>

New section: insert at the end of heating and cooling coil group section.

**Secondary Coils of DX System and Heat Pump**

Secondary Coils reject to or remove heat from a secondary zone as part of a DX system or an air-to-air heat pump. Secondary coil refers to a condenser of a DX system or a heat pump in cooling operating mode or an evaporator of a heat pump in heating mode. The secondary coil (e.g. condenser) of DX system or heat pumps is commonly installed outdoor but when installed inside a zone either heat is dumped to or extracted from a secondary zone. A secondary zone is a conditioned or unconditioned zone where the secondary coil is installed. Secondary coils are not standalone DX coils but they are add-on features on existing DX coil objects. A secondary DX coil is modelled by specifying additional inputs in one of the following DX coil objects: Coil:Cooling:DX:SingleSpeed, Coil:Heating:DX:SingleSpeed, Coil:Cooling:DX:TwoSpeed, Coil:Cooling:DX:MultiSpeed, and Coil:Heating:DX:MultiSpeed. These additional inputs allow us to model the heat rejected or extracted by the secondary coil while the primary (active) coil is serving another controlled zone as shown in Figure 1. A secondary coil is not controlled directly but responds to the requirements of the primary DX coil. Heat is rejected or extracted depending on the primary DX coil operating modes. For instance, heat rejected to a secondary zone by a condenser of a DX system or a heat pump is considered as sensible only whereas the energy extracted from a secondary zone may contain sensible and latent components.



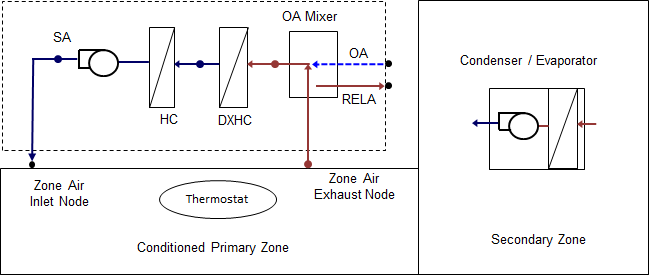
**Figure 1 Schematic of DX System and heat pump in cooling operating mode**

Applications of this technology include: inter-zone heat pump in NTED (DIxon, 2010), and PTAC or PTHP serving Offices attached to a Warehouse, where the office partially or fully enclosed by the warehouse and the condenser is inside the Warehouse. Heat rejected or extracted by the secondary DX coil installed in a secondary zone is estimated from the DX coil models and it is considered as internal gains of the secondary zone. The capacity and electric power input of the DX system and heat pumps are determined from the operating modes of the primary cooling or heating DX coils. Calculation of a secondary coil tracks the operating modes of the primary DX coil serving the primary conditioned zone(s). Currently allowed DX coil models are single speed, two speed and multi speed DX Systems and Heat Pumps. To model secondary DX coils the condenser type should be AirCooled. There is no need to specify the condenser air inlet node. The model uses zone air node as the secondary coil air inlet node. And the fuel type in multispeed DX coils should Electricity.

**Cooling Operating Mode**: the primary DX cooling coil of a DX system serving a primary zone is active and heat is rejected by the secondary coil (condenser) into a secondary zone. The secondary zone name is specified in DX cooling coil objects. This operating mode applies to a DX cooling system and cooling operating mode of air-to-air single and multi-speed heat pumps. Heat rejected by a secondary coil (condenser) calculated at each time step becomes internal gain of the secondary zone as shown in Figure 2. Whenever a secondary zone name is specified in DX cooling coil objects, the secondary DX coil model calculation is invoked. The only input field required to invoke the secondary DX coil in cooling operating model is to add a zone name for the secondary coil (condenser) placement to the DX cooling coil object.

**Field: Zone Name for Condenser Placement**

This input field is name of a conditioned or unconditioned zone where the secondary coil (condenser) of DX system or a heat pump is to be placed. This is an optional input field specified only when user desires to reject the condenser heat into this zone. The heat rejected is modeled as sensible internal gain of a secondary zone.



**Figure 2 Schematic of DX system and secondary coil in cooling mode**

Following is an example input for a single-speed cooling DX coil with secondary DX coil run option.

Coil:Cooling:DX:SingleSpeed,

Heat Pump ACDXCoil 1, !- Name

FanAndCoilAvailSched, !- Availability Schedule Name

autosize, !- Gross Rated Total Cooling Capacity {W}

autosize, !- Gross Rated Sensible Heat Ratio

3.0, !- Gross Rated Cooling COP {W/W}

autosize, !- Rated Air Flow Rate {m3/s}

, !- Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

DX Cooling Coil Air Inlet Node, !- Air Inlet Node Name

Heating Coil Air Inlet Node, !- Air Outlet Node Name

HPACCoolCapFT, !- Total Cooling Capacity Function of Temperature Curve Name

HPACCoolCapFFF, !- Total Cooling Capacity Function of Flow Fraction Curve Name

HPACCOOLEIRFT, !- Energy Input Ratio Function of Temperature Curve Name

HPACCOOLEIRFFF, !- Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR, !- Part Load Fraction Correlation Curve Name

, !- Nominal Time for Condensate Removal to Begin {s}

, !- Ratio of Initial Moisture Evaporation Rate and Steady State Latent Capacity {dimensionless}

, !- Maximum Cycling Rate {cycles/hr}

, !- Latent Capacity Time Constant {s}

, !- Condenser Air Inlet Node Name

AirCooled, !- Condenser Type

, !- Evaporative Condenser Effectiveness {dimensionless}

, !- Evaporative Condenser Air Flow Rate {m3/s}

, !- Evaporative Condenser Pump Rated Power Consumption {W}

, !- Crankcase Heater Capacity {W}

, !- Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation {C}

, !- Supply Water Storage Tank Name

, !- Condensate Collection Water Storage Tank Name

200, !- Basin Heater Capacity {W/K}

, !- Basin Heater Setpoint Temperature

, !- Basin Heater Operating Schedule Name

, !- Sensible Heat Ratio Function of Temperature Curve Name

, !- Sensible Heat Ratio Function of Flow Fraction Curve Name

NORTH ZONE; !- Zone Name for Condenser Placement

Following is an example input for a two-speed cooling DX coil with secondary DX coil run option.

Coil:Cooling:DX:TwoSpeed,

PSZ-AC\_1:1\_CoolC DXCoil, !- Name

FanAndCoilAvailSched, !- Availability Schedule Name

AUTOSIZE, !- High Speed Gross Rated Total Cooling Capacity {W}

AUTOSIZE, !- High Speed Rated Sensible Heat Ratio

3.5, !- High Speed Gross Rated Cooling COP {W/W}

AUTOSIZE, !- High Speed Rated Air Flow Rate {m3/s}

, !- Unit Internal Static Air Pressure {Pa}

DX Cooling Coil Air Inlet Node, !- Air Inlet Node Name

Heating Coil Air Inlet Node, !- Air Outlet Node Name

Measured\_CoolCStandard10Ton\_CapFT,!- Total Cooling Capacity Function of Temperature Curve Name

Measured\_CoolCStandard10Ton\_CapFF,!- Total Cooling Capacity Function of Flow Fraction Curve Name

Measured\_CoolCStandard10Ton\_EIRFT, !- Energy Input Ratio Function of Temperature Curve Name

Measured\_CoolCStandard10Ton\_EIRFFF, !- Energy Input Ratio Function of Flow Fraction Curve Name

No\_PLR\_Degredation, !- Part Load Fraction Correlation Curve Name

AUTOSIZE, !- Low Speed Gross Rated Total Cooling Capacity {W}

AUTOSIZE, !- Low Speed Gross Rated Sensible Heat Ratio

3.3, !- Low Speed Gross Rated Cooling COP {W/W}

AUTOSIZE, !- Low Speed Rated Air Flow Rate {m3/s}

MeasuredLowSpeedCoolCapLSFT,!- Low Speed Total Cooling Capacity Function of Temperature Curve Name

MeasuredLowSpeedCoolEIRLSFT,!- Low Speed Energy Input Ratio Function of Temperature Curve Name

, !- Condenser Air Inlet Node Name

AirCooled, !- Condenser Type

, !- High Speed Evaporative Condenser Effectiveness {dimensionless}

, !- High Speed Evaporative Condenser Air Flow Rate {m3/s}

, !- High Speed Evaporative Condenser Pump Rated Power Consumption {W}

, !- Low Speed Evaporative Condenser Effectiveness {dimensionless}

, !- Low Speed Evaporative Condenser Air Flow Rate {m3/s}

, !- Low Speed Evaporative Condenser Pump Rated Power Consumption {W}

, !- Supply Water Storage Tank Name

, !- Condensate Collection Water Storage Tank Name

, !- Basin Heater Capacity {W/K}

, !- Basin Heater Setpoint Temperature {C}

, !- Basin Heater Operating Schedule Name

, !- Sensible Heat Ratio Function of Temperature Curve Name

, !- Sensible Heat Ratio Function of Flow Fraction Curve Name

, !- Low Speed Sensible Heat Ratio Function of Temperature Curve Name

, !- Low Speed Sensible Heat Ratio Function of Flow Fraction Curve Name

NORTH ZONE; !- Zone Name for Condenser Placement

Following is an example input for a multi-speed cooling DX coil with secondary DX coil run option.

Coil:Cooling:DX:MultiSpeed,

Heat Pump ACDXCoil 1, !- Name

FanAndCoilAvailSched, !- Availability Schedule Name

DX Cooling Coil Air Inlet Node, !- Air Inlet Node Name

Heating Coil Air Inlet Node, !- Air Outlet Node Name

Outdoor Condenser Air Node, !- Condenser Air Inlet Node Name

AirCooled, !- Condenser Type

, !- Supply Water Storage Tank Name

, !- Condensate Collection Water Storage Tank Name

No, !- Apply Part Load Fraction to Speeds Greater than 1

No, !- Apply Latent Degradation to Speeds Greater than 1

200.0, !- Crankcase Heater Capacity {W}

10.0, !- Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation {C}

, !- Basin Heater Capacity {W/K}

, !- Basin Heater Setpoint Temperature {C}

, !- Basin Heater Operating Schedule Name

Electricity, !- Fuel Type

4, !- Number of Speeds

autosize, !- Speed 1 Gross Rated Total Cooling Capacity {W}

autosize, !- Speed 1 Gross Rated Sensible Heat Ratio

3.0, !- Speed 1 Gross Rated Cooling COP {W/W}

autosize, !- Speed 1 Rated Air Flow Rate {m3/s}

453.3, !- Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACCoolCapFT Speed 1, !- Speed 1 Total Cooling Capacity Function of Temperature Curve Name

HPACCoolCapFF Speed 1, !- Speed 1 Total Cooling Capacity Function of Flow Fraction Curve Name

HPACCOOLEIRFT Speed 1, !- Speed 1 Energy Input Ratio Function of Temperature Curve Name

HPACCOOLEIRFF Speed 1, !- Speed 1 Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR Speed 1, !- Speed 1 Part Load Fraction Correlation Curve Name

1000.0, !- Speed 1 Nominal Time for Condensate Removal to Begin {s}

1.5, !- Speed 1 Ratio of Initial Moisture Evaporation Rate and Steady State Latent Capacity {dimensionless}

3.0, !- Speed 1 Maximum Cycling Rate {cycles/hr}

45.0, !- Speed 1 Latent Capacity Time Constant {s}

0.2, !- Speed 1 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCCoolWHFT Speed 1, !- Speed 1 Waste Heat Function of Temperature Curve Name

0.9, !- Speed 1 Evaporative Condenser Effectiveness {dimensionless}

autosize, !- Speed 1 Evaporative Condenser Air Flow Rate {m3/s}

50, !- Speed 1 Rated Evaporative Condenser Pump Power Consumption {W}

autosize, !- Speed 2 Gross Rated Total Cooling Capacity {W}

autosize, !- Speed 2 Gross Rated Sensible Heat Ratio

3.0, !- Speed 2 Gross Rated Cooling COP {W/W}

autosize, !- Speed 2 Rated Air Flow Rate {m3/s}

523.3, !- Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACCoolCapFT Speed 2, !- Speed 2 Total Cooling Capacity Function of Temperature Curve Name

HPACCoolCapFF Speed 2, !- Speed 2 Total Cooling Capacity Function of Flow Fraction Curve Name

HPACCOOLEIRFT Speed 2, !- Speed 2 Energy Input Ratio Function of Temperature Curve Name

HPACCOOLEIRFF Speed 2, !- Speed 2 Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR Speed 1, !- Speed 2 Part Load Fraction Correlation Curve Name

1000.0, !- Speed 2 Nominal Time for Condensate Removal to Begin {s}

1.5, !- Speed 2 Ratio of Initial Moisture Evaporation Rate and steady state Latent Capacity {dimensionless}

3.0, !- Speed 2 Maximum Cycling Rate {cycles/hr}

45.0, !- Speed 2 Latent Capacity Time Constant {s}

0.2, !- Speed 2 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCCoolWHFT Speed 2, !- Speed 2 Waste Heat Function of Temperature Curve Name

0.9, !- Speed 2 Evaporative Condenser Effectiveness {dimensionless}

autosize, !- Speed 2 Evaporative Condenser Air Flow Rate {m3/s}

60, !- Speed 2 Rated Evaporative Condenser Pump Power Consumption {W}

autosize, !- Speed 3 Gross Rated Total Cooling Capacity {W}

autosize, !- Speed 3 Gross Rated Sensible Heat Ratio

3.0, !- Speed 3 Gross Rated Cooling COP {W/W}

autosize, !- Speed 3 Rated Air Flow Rate {m3/s}

573.3, !- Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACCoolCapFT Speed 3, !- Speed 3 Total Cooling Capacity Function of Temperature Curve Name

HPACCoolCapFF Speed 3, !- Speed 3 Total Cooling Capacity Function of Flow Fraction Curve Name

HPACCOOLEIRFT Speed 3, !- Speed 3 Energy Input Ratio Function of Temperature Curve Name

HPACCOOLEIRFF Speed 3, !- Speed 3 Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR Speed 1, !- Speed 3 Part Load Fraction Correlation Curve Name

1000.0, !- Speed 3 Nominal Time for Condensate Removal to Begin {s}

1.5, !- Speed 3 Ratio of Initial Moisture Evaporation Rate and steady state Latent Capacity {dimensionless}

3.0, !- Speed 3 Maximum Cycling Rate {cycles/hr}

45.0, !- Speed 3 Latent Capacity Time Constant {s}

0.2, !- Speed 3 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCCoolWHFT Speed 3, !- Speed 3 Waste Heat Function of Temperature Curve Name

0.9, !- Speed 3 Evaporative Condenser Effectiveness {dimensionless}

autosize, !- Speed 3 Evaporative Condenser Air Flow Rate {m3/s}

80, !- Speed 3 Rated Evaporative Condenser Pump Power Consumption {W}

autosize, !- Speed 4 Gross Rated Total Cooling Capacity {W}

autosize, !- Speed 4 Gross Rated Sensible Heat Ratio

3.0, !- Speed 4 Gross Rated Cooling COP {W/W}

autosize, !- Speed 4 Rated Air Flow Rate {m3/s}

673.3, !- Rated Evaporator Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACCoolCapFT Speed 4, !- Speed 4 Total Cooling Capacity Function of Temperature Curve Name

HPACCoolCapFF Speed 4, !- Speed 4 Total Cooling Capacity Function of Flow Fraction Curve Name

HPACCOOLEIRFT Speed 4, !- Speed 4 Energy Input Ratio Function of Temperature Curve Name

HPACCOOLEIRFF Speed 4, !- Speed 4 Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR Speed 1, !- Speed 4 Part Load Fraction Correlation Curve Name

1000.0, !- Speed 4 Nominal Time for Condensate Removal to Begin {s}

1.5, !- Speed 4 Ratio of Initial Moisture Evaporation Rate and steady state Latent Capacity {dimensionless}

3.0, !- Speed 4 Maximum Cycling Rate {cycles/hr}

45.0, !- Speed 4 Latent Capacity Time Constant {s}

0.2, !- Speed 4 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCCoolWHFT Speed 4, !- Speed 4 Waste Heat Function of Temperature Curve Name

0.9, !- Speed 4 Evaporative Condenser Effectiveness {dimensionless}

autosize, !- Speed 4 Evaporative Condenser Air Flow Rate {m3/s}

100, !- Speed 4 Rated Evaporative Condenser Pump Power Consumption {W}

NORTH ZONE; !- Zone Name for Condenser Placement

**Heating Operating Mode**: When a heat pump operates in heating mode then energy is extracted from the secondary zone. Total energy extracted from a secondary zone may contain sensible and latent components. The secondary coil (evaporator) model checks for the coil inlet and outlet air condition to determine if dehumidification has occurred. The sensible and latent split of the energy extracted is done using a user specified rated sensible heat ratio (SHR) and SHR modifier curves for temperature and secondary air flow fraction. If the coil operation is dry, then the SHR is set to 1.0. In addition, the model assumes that condensed water is drained to the outside. If defrosting operation is on, then the defrosting melts the frost and the liquid water from the collecting pan is drained to the outside. Thus, defrosting energy is not included in the zone energy balance. The six optioal input fields required in the DX heating coils are the following. The last five input fields are extensible depending on the speed of the heating DX coil.

***Field: Zone Name for Evaporator Placement***

This input field is name of a conditioned or unconditioned zone where the secondary coil (evaporator) of a heat pump is installed. This is an optional input field specified only when user desires to extract heat from the zone via secondary coil. Heat extracted is modeled as internal gain. If the primary DX system is a heat pump, then the zone name should be the same as the zone name specified for placing the secondary cooling DX coil.

***Field: Speed <x>*** ***Secondary Coil Air Flow Rate***

This input value is the secondary coil (evaporator) air flow rate when the heat pump is working in heating mode or the secondary coil (condenser) air flow rate when the heat pump is working in cooling mode. This input field is auto-sizable.

***Field: Speed <x>*** ***Secondary Coil Fan Flow Scaling Factor***

This input field is scaling factor for autosizing the secondary DX coil fan flow rate. The secondary air flow rate is determined by multiplying the primary DX coil rated air flow rate by the fan flow scaling factor. Default value is 1.25. If the secondary coil fan flow rate is not autosized, then the secondary coil fan flow scaling factor is set to 1.0.

***Field: Speed <x>*** ***Nominal Sensible Heat Ratio of Secondary Coil***

This input value is the nominal sensible heat ratio used to split the heat extracted by a secondary DX coil (evaporator) of a heat pump into sensible and latent components. This is an optional input field. If this input field is left blank, then pure sensible internal heat gain is assumed, i.e., sensible heat ratio of 1.0.

***Field: Speed <x>*** ***Sensible Heat Ratio Modifier Function of Temperature Curve Name***

This input field is name of sensible heat ratio modifier biquadratic curve. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary zone air node wet-bulb temperature and the heating DX coil entering air dry-bulb temperature. This is an optional input field. If this input field is left blank, then the nominal sensible heat ratio modifier curve value for temperature is set to 1.0.

***Field: Speed <x>*** ***Sensible Heat Ratio Modifier Function of Flow Fraction Curve Name***

This input field is name of sensible heat ratio modifier curve as function of secondary air flow fraction. The value of this curve modifies the nominal sensible heat ratio for current time step depending on the secondary coil air flow fraction. This is an optional input field. If this input field is left blank, then the sensible heat ratio modifier curve value for flow fraction is set to 1.0.

Following is an example input for a single-speed heating DX coil with secondary DX coil run option.

Coil:Heating:DX:SingleSpeed,

Heat Pump DX Heating Coil 1, !- Name

FanAndCoilAvailSched, !- Availability Schedule Name

autosize, !- Gross Rated Heating Capacity {W}

2.75, !- Gross Rated Heating COP {W/W}

autosize, !- Rated Air Flow Rate {m3/s}

, !- Rated Supply Fan Power Per Volume Flow Rate {W/(m3/s)}

Heating Coil Air Inlet Node, !- Air Inlet Node Name

SuppHeating Coil Air Inlet Node, !- Air Outlet Node Name

HPACHeatCapFT, !- Heating Capacity Function of Temperature Curve Name

HPACHeatCapFFF, !- Heating Capacity Function of Flow Fraction Curve Name

HPACHeatEIRFT, !- Energy Input Ratio Function of Temperature Curve Name

HPACHeatEIRFFF, !- Energy Input Ratio Function of Flow Fraction Curve Name

HPACCOOLPLFFPLR, !- Part Load Fraction Correlation Curve Name

, !- Defrost Energy Input Ratio Function of Temperature Curve Name

-5.0, !- Minimum Outdoor Dry-Bulb Temperature for Compressor Operation {C}

, !- Outdoor Dry-Bulb Temperature to Turn On Compressor {C}

5.0, !- Maximum Outdoor Dry-Bulb Temperature for Defrost Operation {C}

200.0, !- Crankcase Heater Capacity {W}

10.0, !- Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation {C}

Resistive, !- Defrost Strategy

TIMED, !- Defrost Control

0.166667, !- Defrost Time Period Fraction

autosize, !- Resistive Defrost Heater Capacity {W}

4, !- Region number for calculating HSPF

, !- Evaporator Air Inlet Node Name

NORTH ZONE, !- Zone Name for Evaporator Placement

autosize, !- Secondary Coil Air Flow Rate

1.5, !- Secondary Coil Fan Flow Scaling Factor

0.9, !- Nominal Sensible Heat Ratio of Secondary Coil

DXSecondaryCoilSHRFT, !- Sensible Heat Ratio Modifier Function of Temperature Curve Name

DXSecondaryCoilSHRFFF; !- Sensible Heat Ratio Function of Flow Fraction Curve Name

Following is an example input for a multi-speed heating DX coil with secondary DX coil run option.

Coil:Heating:DX:MultiSpeed,

Heat Pump DX Heating Coil 1, !- Name

FanAndCoilAvailSched, !- Availability Schedule Name

Heating Coil Air Inlet Node, !- Air Inlet Node Name

SuppHeating Coil Air Inlet Node, !- Air Outlet Node Name

-8.0, !- Minimum Outdoor Dry-Bulb Temperature for Compressor Operation {C}

-5.0, !- Outdoor Dry-Bulb Temperature to Turn On Compressor {C}

200.0, !- Crankcase Heater Capacity {W}

10.0, !- Maximum Outdoor Dry-Bulb Temperature for Crankcase Heater Operation {C}

HPACDefrostCAPFT, !- Defrost Energy Input Ratio Function of Temperature Curve Name

7.22, !- Maximum Outdoor Dry-Bulb Temperature for Defrost Operation {C}

ReverseCycle, !- Defrost Strategy

timed, !- Defrost Control

0.058333, !- Defrost Time Period Fraction

autosize, !- Resistive Defrost Heater Capacity {W}

No, !- Apply Part Load Fraction to Speeds Greater than 1

Electricity, !- Fuel Type

4, !- Region number for Calculating HSPF

4, !- Number of Speeds

autosize, !- Speed 1 Gross Rated Heating Capacity {W}

2.75, !- Speed 1 Gross Rated Heating COP {W/W}

autosize, !- Speed 1 Rated Air Flow Rate {m3/s}

345.0, !- Speed 1 Rated Supply Air Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACHeatCapFT Speed 1, !- Speed 1 Heating Capacity Function of Temperature Curve Name

HPACHeatCapFF Speed 1, !- Speed 1 Heating Capacity Function of Flow Fraction Curve Name

HPACHeatEIRFT Speed 1, !- Speed 1 Energy Input Ratio Function of Temperature Curve Name

HPACHeatEIRFF Speed 1, !- Speed 1 Energy Input Ratio Function of Flow Fraction Curve Name

HPACHeatPLFFPLR Speed 1, !- Speed 1 Part Load Fraction Correlation Curve Name

0.2, !- Speed 1 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCHeatWHFT Speed 1, !- Speed 1 Waste Heat Function of Temperature Curve Name

autosize, !- Speed 2 Gross Rated Heating Capacity {W}

2.75, !- Speed 2 Gross Rated Heating COP {W/W}

autosize, !- Speed 2 Rated Air Flow Rate {m3/s}

425.0, !- Speed 2 Rated Supply Air Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACHeatCapFT Speed 2, !- Speed 2 Heating Capacity Function of Temperature Curve Name

HPACHeatCapFF Speed 2, !- Speed 2 Heating Capacity Function of Flow Fraction Curve Name

HPACHeatEIRFT Speed 2, !- Speed 2 Energy Input Ratio Function of Temperature Curve Name

HPACHeatEIRFF Speed 2, !- Speed 2 Energy Input Ratio Function of Flow Fraction Curve Name

HPACHeatPLFFPLR Speed 2, !- Speed 2 Part Load Fraction Correlation Curve Name

0.2, !- Speed 2 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCHeatWHFT Speed 2, !- Speed 2 Waste Heat Function of Temperature Curve Name

autosize, !- Speed 3 Gross Rated Heating Capacity {W}

2.75, !- Speed 3 Gross Rated Heating COP {W/W}

autosize, !- Speed 3 Rated Air Flow Rate {m3/s}

525.0, !- Speed 3 Rated Supply Air Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACHeatCapFT Speed 3, !- Speed 3 Heating Capacity Function of Temperature Curve Name

HPACHeatCapFF Speed 3, !- Speed 3 Heating Capacity Function of Flow Fraction Curve Name

HPACHeatEIRFT Speed 3, !- Speed 3 Energy Input Ratio Function of Temperature Curve Name

HPACHeatEIRFF Speed 3, !- Speed 3 Energy Input Ratio Function of Flow Fraction Curve Name

HPACHeatPLFFPLR Speed 3, !- Speed 3 Part Load Fraction Correlation Curve Name

0.2, !- Speed 3 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCHeatWHFT Speed 3, !- Speed 3 Waste Heat Function of Temperature Curve Name

autosize, !- Speed 4 Gross Rated Heating Capacity {W}

2.75, !- Speed 4 Gross Rated Heating COP {W/W}

autosize, !- Speed 4 Rated Air Flow Rate {m3/s}

673.0, !- Speed 4 Rated Supply Air Fan Power Per Volume Flow Rate {W/(m3/s)}

HPACHeatCapFT Speed 4, !- Speed 4 Heating Capacity Function of Temperature Curve Name

HPACHeatCapFF Speed 4, !- Speed 4 Heating Capacity Function of Flow Fraction Curve Name

HPACHeatEIRFT Speed 4, !- Speed 4 Energy Input Ratio Function of Temperature Curve Name

HPACHeatEIRFF Speed 4, !- Speed 4 Energy Input Ratio Function of Flow Fraction Curve Name

HPACHeatPLFFPLR Speed 4, !- Speed 4 Part Load Fraction Correlation Curve Name

0.2, !- Speed 4 Rated Waste Heat Fraction of Power Input {dimensionless}

HAPCHeatWHFT Speed 4, !- Speed 4 Waste Heat Function of Temperature Curve Name

NORTH ZONE, !- Zone Name for Evaporator Placement

autosize, !- Speed 1 Secondary Coil Air Flow Rate

1.5, !- Speed 1 Secondary Coil Fan Flow Scaling Factor

0.9, !- Speed 1 Nominal Sensible Heat Ratio of Secondary Coil

DXSecondaryCoilSHRFT,!- Speed 1 Sensible Heat Ratio Modifier Function of Temperature Curve Name

DXSecondaryCoilSHRFFF, !- Speed 1 Sensible Heat Ratio Function of Flow Fraction Curve Name

autosize, !- Speed 2 Secondary Coil Air Flow Rate

1.5, !- Speed 2 Secondary Coil Fan Flow Scaling Factor

0.9, !- Speed 2 Nominal Sensible Heat Ratio of Secondary Coil

DXSecondaryCoilSHRFT,!- Speed 2 Sensible Heat Ratio Modifier Function of Temperature Curve Name

DXSecondaryCoilSHRFFF, !- Speed 2 Sensible Heat Ratio Function of Flow Fraction Curve Name

autosize, !- Speed 3 Secondary Coil Air Flow Rate

1.5, !- Speed 3 Secondary Coil Fan Flow Scaling Factor

0.9, !- Speed 3 Nominal Sensible Heat Ratio of Secondary Coil

DXSecondaryCoilSHRFT,!- Speed 3 Sensible Heat Ratio Modifier Function of Temperature Curve Name

DXSecondaryCoilSHRFFF, !- Speed 3 Sensible Heat Ratio Function of Flow Fraction Curve Name

autosize, !- Speed 4 Secondary Coil Air Flow Rate

1.5, !- Speed 4 Secondary Coil Fan Flow Scaling Factor

0.9, !- Speed 4 Nominal Sensible Heat Ratio of Secondary Coil

DXSecondaryCoilSHRFT,!- Speed 4 Sensible Heat Ratio Modifier Function of Temperature Curve Name

DXSecondaryCoilSHRFFF; !- Speed 4 Sensible Heat Ratio Function of Flow Fraction Curve Name

**Secondary DX Coil Output**:

HVAC, Average, Secondary Coil Heat Rejection Rate [W]

HVAC, Average, Secondary Coil Total Heat Removal Rate [W]

HVAC, Average, Secondary Coil Sensible Heat Removal Rate [W]

HVAC, Average, Secondary Coil Latent Heat Removal Rate [W]

HVAC, Average, Secondary Coil Sensible Heat Ratio []

HVAC, Average, Secondary Coil Compressor Part Load Ratio []

#### Secondary Coil Heat Rejection Rate [W]

This is the sensible heat rejected to a zone by a secondary DX coil (condenser) in Watts. This is sum of the total cooling rate of a DX cooling coil and cooling electric power of the primary DX coil. This heat is applied as an internal gain to the secondary zone where the condenser is installed.

#### Secondary Coil Total Heat Removal Rate [W]

This is the total energy removed from a a zone by a secondary DX coil (evaporator) in Watts. This is the total heating rate of the primary DX cooling coil minus the heating electric power of the primary DX coil. This heat is extracted from the secondary zone when the heat pump is operating in heating mode. The negative sign indicate that heat is removed from the zone.

#### Secondary Coil Sensible Heat Removal Rate [W]

This is the sensible heat removed from a a zone by a secondary DX coil (evaporator) in Watts. This is determined by multiplying the total heat removed with sensible heat ratio of the secondary coil. This heat is extracted from the secondary zone when the heat pump is operating in heating mode. The negative sign indicate that sensible heat is removed from the zone.

#### Secondary Coil Latent Heat Removal Rate [W]

This is the latent heat removed from a a zone by a secondary DX coil (evaporator) in Watts. This is the difference between the total heat removal rate and the sensible heat remobal rate of the secondary coil. This heat is extracted from the secondary zone when the heat pump is operating in heating mode. The negative sign indicate that moisture is removed from the zone.

#### Secondary Coil Sensible Heat Ratio []

This is the operating sensible heat ratio the secondary DX coil (condenser) when the heat pump is operating in heating mode.

#### Secondary Coil Compressor Part Load Ratio []

This is the compressor part load ratio when the heat pump is operating in heating mode and the secondary coil is extracting heat from a zone where the coil is installed. The secondary coil DX coil compressor part load ratio can be different from the primary DX coil compressor part load ratio in that the later may include the defrosting load.

Reference: DIxon, Erin Elizabeth, "Energy Model Development and Heating Energy Investigation of the Nested Thermal Envelope Design (NTED (tm))" (2010). *Theses and dissertations.* Paper 974.

## Group – Fans

1. The 23.9°C wet-bulb temperature condition is not applicable for air-cooled condensers which do not evaporate condensate. [↑](#footnote-ref-1)
2. The 23.9°C wet-bulb temperature condition is not applicable for air-cooled condensers which do not evaporate condensate. [↑](#footnote-ref-2)
3. The 23.9°C wet-bulb temperature condition is not applicable for air-cooled condensers which do not evaporate condensate. [↑](#footnote-ref-3)