# THE HVAC COMPONENT LIBRARY (GENERAL DESCRIPTIONS)

## TYPE 505: WATER SOURCE HEAT PUMP

This component models a single-stage liquid source heat pump with an optional desuperheater for hot water heating. The heat pump conditions a moist air stream by rejecting energy to (cooling mode) or absorbing energy from (heating mode) a liquid stream. This heat pump model was intended for a residential ground source heat pump application, but may be used in any liquid source application.

The heat pump has a desuperheater attached to a secondary fluid stream. In cooling mode, the desuperheater relieves the liquid stream of some of the burden of rejecting energy. However, in heating mode, the desuperheater requires the liquid stream to absorb more energy than is just required for space
heating.

This model is based on user-supplied data files containing catalog data for the capacity (both total and sensible in cooling mode), and power, based on the entering water temperature to the heat pump, the entering water flow rate and the air flow rate. Other curve fits are used to modify the capacities and power based on off-design indoor air temperatures. Type505 takes either air relative humidity or absolute humidity ratio as an input. It is identical to Type504 in the TESS Ground Source Heat Pump Library. Formerly, Type505 took air relative humidity while Type504 took air humidity ratio as an input.

## TYPE 506: DIRECT EVAPORATIVE COOLER (SWAMP COOLER)

Type506 models an evaporative cooling device for which the user supplies the inlet air conditions and the saturation efficiency and the model calculates the outlet air conditions. The cooling process is assumed to be a constant wet bulb temperature process meaning that air enters and exits at the same wet bulb temperature. The device is not equipped with controls that monitor the conditions of the outlet air. When the device is ON (based on a user supplied control signal value), Type506 cools the air as much as it can given the entering conditions and the device efficiency. If a controlled evaporative cooling device is more appropriate to the user's circumstances, Type507 may be used. Type507 models a similar direct evaporative cooling device but takes a target air outlet relative humidity.

## TYPE 507: CONTROLLED DIRECT EVAPORATIVE COOLING DEVICE (FOGGING DEVICE)

Type507 models an evaporative cooling device for which the user supplies the inlet air conditions and a target air outlet relative humidity. The outlet air dry bulb temperature is modulated given to achieve the desired outlet relative humidity. The cooling process is assumed to be a constant wet bulb temperature process meaning that air enters and exits at the same wet bulb temperature.

## TYPE 508: COOLING COIL WITH VARIOUS CONTROL MODES

Type508 models a cooling coil using one of four control modes. The cooling coil is modeled using a bypass approach in which the user specifies a fraction of the air stream that bypasses the coil. The remainder of the air stream is assumed to exit the coil at the average temperature of the fluid in the coil and at saturated conditions. The two air streams are remixed after the coil. In its unrestrained (uncontrolled) mode of operation, the coil cools and dehumidifies the air stream as much as possible given the inlet conditions of both the air and the fluid streams. The model is alternatively able to internally bypass fluid around the coil so as to maintain the outlet air dry bulb temperature above a user specified minimum, to maintain the air outlet absolute humidity ratio above a user specified minimum or to maintain the fluid outlet temperature below some user specified maximum.

## TYPE 510: CLOSED CIRCUIT COOLING TOWER

Type510 models a closed circuit cooling tower; a device used to cool a liquid stream by evaporating water from the outside of coils containing the working fluid. The working fluid is completely isolated from the air and water in this type of system. Closed circuit cooling towers are often referred to as indirect cooling towers or indirect evaporators.

## TYPE 641: SIMPLE ADIABADIC HUMIDIFER

This model represents a simple adiabatic humidifier whose outlet air state is determined by an energy balance. Thermal losses from the humidifier are neglected. The model allows for the humidifier not to respond immediately to the control

signal but to reach its steady state moisture gain rate exponentially. Furthermore, the model allows the user to determine whether condensate leaves the humidifier at the temperature at which it enters, at the temperature of the air exiting the humidifier or at any point in between.

## TYPE 643: SIMPLE FURNACE / AIR HEATER

Much like Type6 does for fluids, Type643 represents an air heating device that can be controlled either externally, or set to automatically try and attain a set point temperature. The furnace is bound by a heating capacity and an efficiency. Thermal losses from the furnace are based on the average air temperature. The outlet state of the air is determined by an enthalpy based energy balance that takes pressure effects into account.

## TYPE 650: HEAT EXCHANGER WITH HOT-SIDE BYPASS TO KEEP COLD-SIDE OUTLET BELOW ITS SETPOINT

Type650 models a constant effectiveness / $C_{min}$ heat exchanger that is able to automatically bypass hot-side fluid around the heat exchanger in order to maintain the cold-side outlet temperature below a user specified, time dependent set point. The bypass may be enabled or disabled at any point during the simulation if desired.

## TYPE 651: RESIDENTIAL COOLING COIL (AIR CONDITIONER)

Type651 models a residential cooling coil, more commonly known as a residential air conditioner. It relies on catalog data provided as external text files to determine coil performance. Example data files and information on data file format are provided. This component is functionally identical to Type756 except that Type756 takes a different data file format.

## TYPE 652: HEAT EXCHANGER WITH HOT-SIDE BYPASS TO KEEP COLD-SIDE OUTLET ABOVE ITS SETPOINT

Type652 models a constant effectiveness / $C_{min}$ heat exchanger that is able to automatically bypass hot-side fluid around the heat exchanger in order to maintain the cold-side outlet temperature above a user specified, time dependent set point. The bypass may be enabled or disabled at any point during the simulation if desired.

## TYPE 655: AIR COOLED CHILLER

Type655 models a vapor compression air cooled chiller. It relies on catalog data provided as external text files to determine chiller performance. Example data files and information on data file format are provided.

## TYPE 657: HEAT EXCHANGER WITH COLD-SIDE BYPASS TO KEEP HOT-SIDE OUTLET BELOW ITS SETPOINT

Type657 models a constant effectiveness / $C_{min}$ heat exchanger that is able to automatically bypass cold-side fluid around the heat exchanger in order to maintain the hot-side outlet temperature below a user specified, time dependent set point. The bypass may be enabled or disabled at any point during the simulation if desired.

## TYPE 659: AUXILIARY FLUID HEATER WITH PROPORTIONAL CONTROL (PROPORTIONAL BOILER)

Type659 models an external, proportionally controlled fluid heater. External proportional control (an input signal between 0 and 1) is in effect as long as a fluid set point temperature is not exceeded. If the set point is exceeded, the proportional control is internally modified to limit the fluid outlet temperature to the set point as with Type6.

## TYPE 663: ELECTRIC UNIT HEATER WITH VARIABLE SPEED FAN AND PROPORTIONAL CONTROL

Type663 models an electric unit heater whose fan speed and heating power are proportionally and externally controlled. Proportional control indicates that both fan speed and heating power can vary between 0 and their rated values. External control indicates that the fraction of rated capacity or speed is specified as a time dependent value by the user and is provided to the model as an input. The heater is designed not to exceed a user specified set point temperature. If at any point in the simulation the heater capacity and control signal would result in an outlet temperature higher than the set point, the external control signal value will be overridden. Fan power is specified as a polynomial relating normalized mass flow rate to normalized fan power. The user may control the extent to which the fan power results in a temperature rise in the air stream.

## TYPE 664: ELECTRIC UNIT HEATER WITH VARIABLE SPEED FAN, PROPORTIONAL CONTROL, AND

## DAMPER CONTROL

Type664 models an electric unit heater whose fan speed, heating power, and fraction of outdoor air are proportionally and externally controlled. Proportional control indicates that these three variables can have any value between 0 and their rated values. External control indicates that the fraction of rated capacity, speed, or outdoor air is specified as a time dependent value by the user and is provided to the model as an input. The heater is designed not to exceed a user specified set point temperature. If at any point in the simulation the heater capacity and control signal would result in an outlet temperature higher than the set point, the external control signal value will be overridden. Fan power is specified as a polynomial relating normalized mass flow rate to normalized fan power. The user may also control the extent to which the fan power results in a temperature rise in the air stream.

## TYPE 665: AIR SOURCE HEAT PUMP (SPLIT SYSTEM HEAT PUMP)

Type665 uses a manufacturer's catalog data approach to model an air source heat pump (air flows on both the condenser and evaporator sides of the device. The model includes mixing algorithms and damper settings so that the indoor air may be the result of two streams from different sources (recirculation and makeup air for example. In heating mode, the device is equipped with one of three auxiliary heater types: no auxiliary heat available, two element electric auxiliary heat, or gas fired auxiliary heat. The model is also equipped with a capacity multiplier parameter so that the heat pump may be quickly resized without having to resort to finding new data files.

## TYPE 666: WATER COOLED CHILLER

Type666 models a vapor compression style water cooled chiller. It relies on catalog data provided as external text files to determine chiller performance. Example data files and information on data file format are provided.

## TYPE 667: AIR TO AIR HEAT RECOVERY DEVICE

Type667 uses a "constant effectiveness – minimum capacitance" approach to model an air to air heat recovery device in which two air streams are passed near each other so that both energy and possibly moisture may be transferred between the streams. Because of the "constant effectiveness – minimum capacitance" methodology, the model may be used to model a device with any configuration of air streams (parallel flow, cross flow, counter flow, etc.) and may be used to model the sensible and latent aspects of an air to air heat exchanger, an enthalpy wheel, a hygroscopic heat exchanger or a permeable walled flat plate recuperator, among other devices.

## TYPE 668: WATER – WATER HEAT PUMP

This component models a single-stage heat pump. The heat pump conditions a one liquid stream by rejecting energy to (cooling mode) or absorbing energy from (heating mode) a second. This model is based on user-supplied data files containing catalog data for the capacity and power draw, based on the entering load and source temperatures. Type668 operates in temperature level control much like an actual heat pump would; when the user defined control signal indicates that the unit should be ON in either heating or cooling mode, it operates at its capacity level until the control signal values changes.

## TYPE 670: AIR HEATING COIL (KEEPS THE OUTLET AIR TEMPERATURE BELOW A USER-SPECIFIED SETPOINT)

Type670 simulates an air heating coil with an internally controlled bypass damper that acts to maintain the outlet air temperature above the inlet air temperature and below a user-specified set point temperature.

## TYPE 673: TWO PIPE CONSOLE UNIT IN ENERGY RATE CONTROL

Type673 models a piece of HVAC equipment commonly known as a two pipe console unit. Such devices pass air across a tube bank that contains either hot or cold fluid. Depending upon the temperature of the air and the fluid, the air will exit either hotter or colder than it entered. Type673 models a two pipe console unit in energy rate control mode, meaning that sensible and latent loads are inputs to the model. Type673 includes a "number of identical units" parameter that allows for easy scaling of the system to meet the building load.

## TYPE 676: DOUBLE-EFFECT STEAM-FIRED ABSORPTION CHILLER

Type676 uses a normalized catalog data lookup approach to model a double-effect steam-fired absorption chiller. “Steam-Fired” indicates that the energy supplied to the machine’s generator comes from a steam source. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided.

## TYPE 677: DOUBLE-EFFECT HOT WATER-FIRED ABSORPTION CHILLER

Type677 uses a normalized catalog data lookup approach to model a double-effect hot-water fired absorption chiller. “Hot Water-Fired” indicates that the energy supplied to the machine’s generator comes from a hot water stream. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided.

## TYPE 678: DOUBLE-EFFECT DIRECT-FIRED ABSORPTION CHILLER

Type678 uses a normalized catalog data lookup approach to model a double-effect direct fired absorption chiller. “Direct Fired” indicates that the energy that must be supplied to the machine’s generator comes from a burner (natural gas or other combustible fuel) built into the machine. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided.

## TYPE 679: SINGLE-EFFECT STEAM-FIRED ABSORPTION CHILLER

Type679 uses a normalized catalog data lookup approach to model a single-effect steam-fired absorption chiller. “Steam-Fired” indicates that the energy supplied to the machine’s generator comes from a steam source. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided.

## TYPE 680: SINGLE-EFFECT HOT WATER-FIRED ABSORPTION CHILLER

Type680 uses a normalized catalog data lookup approach to model a single-effect hot-water fired absorption chiller. “Hot Water-Fired” indicates that the energy supplied to the machine’s generator comes from a hot water stream. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided. Type680 was made a standard TRNSYS Component (Type107) with the release of TRNSYS 16.

## TYPE 681: SINGLE-EFFECT DIRECT-FIRED ABSORPTION CHILLER

Type681 uses a normalized catalog data lookup approach to model a single-effect direct fired absorption chiller. “Direct Fired” indicates that the energy that must be supplied to the machine’s generator comes from a series of burners built into the device. Because the data files are normalized, the user may model any size chiller using a given set of data files. Example files are provided.

## TYPE 683: ROTARY DESICCANT DEHUMIDIFIER

This component models a rotary desiccant dehumidifier containing nominal silica gel whose performance is based on equations for F1-F2 potentials developed by Jurinak. The model determines the regeneration temperature at ambient humidity ratio which will dehumidify process air to the a user specified humidity ratio. The process stream and regeneration stream outlet conditions are determined as well.

## TYPE 684: AIR SIDE ECONOMIZER

Type684 models an air side economizer that internally determines an appropriate mixture of outside and return air that will result in air delivered to the zone at the same temperature, enthalpy, or humidity ratio as air that would be delivered by a cooling coil.

## TYPE 688: DEHUMIDIFIER

Type688 models a stand-alone “all in one” dehumidifier in which the air stream is in contact with the evaporator section (cools and dehumidifies the air), and with the condenser section (reheats the air) of the refrigerant loop. The user can control the amount of heat that is added to the flow stream by setting an input value; a value of zero signifies that no air reheating is done and that all the compressor and evaporator energy is rejected to the surroundings. A value of one signifies that all the compressor and evaporator energy is added back into the air stream flowing across the coils. The model relies on a data file containing performance data at various entering air conditions. The power reported in this data file should contain only the compressor power as the fan power is handled separately.

## TYPE 689: HEAT PIPE

Type689 models a passive device called a heat pipe, which transfers energy from one fluid stream to another - often times the same fluid stream but with a heating or cooling device inserted between the two heat exchangers of the heat pipe. Heat pipes are commonly used in dehumidification applications where warm humid air is cooled to near its dew point using the heat pipe, then is further cooled and dehumidified in a dehumidifier, then is passed back across the other end of the heat pipe where it is reheated using the heat removed from the first cooling in the heat pipe.

## TYPE 692: PERFORMANCE MAP FLUID COOLER

Type692 models a simple fluid cooling device. The model relies on an external, user-supplied data file that contains device capacity and COP as a function of the inlet fluid temperature and a sink temperature.

## TYPE 696: AIR STREAM CONDITIONING DEVICE

Type696 models a simple air conditioning device that adds or removes sensible and latent energy from an air stream to meet user-specified set point conditions of temperature and / or humidity. In this device the sensible condition controls the latent decisions. In other words the device cannot heat and dehumidify or cool and humidify the air stream. It can, however, heat and humidify or cool and dehumidify. To use the component effectively as a dehumidifying coil, set the set point temperature in cooling to the inlet air temperature and the humidity set point to desired level, then set the IREHEAT parameter value to 1 so that the air is returned (through reheat after dehumidification) to its inlet condition or set IREHEAT to 0 allow for a free-floating outlet temperature. To operate this component as a temperature controlled device only, choose the RH input mode and set the RH set point to 100% in cooling and to 0% in heating.

## TYPE 697: PERFORMANCE MAP COOLING COIL

Type697 models a simple air cooling device that removes energy from an air stream according to performance data found in a combination of three external data files and based upon the flow rates and inlet conditions of the air stream and a liquid stream. Normally a water stream is used but if the external data is available for other liquids, that data can be used equally well.

## TYPE 699: HEAT EXCHANGER WITH COLD-SIDE BYPASS TO KEEP HOT-SIDE OUTLET ABOVE ITS SETPOINT

Type699 models a constant effectiveness / $C_{min}$ heat exchanger that is able to automatically bypass hot-side fluid around the heat exchanger in order to maintain the cold-side outlet temperature above a user specified, time dependent set point. The bypass may be enabled or disabled at any point during the simulation if desired.

## TYPE 700: SIMPLE BOILER WITH EFFICIENCY INPUTS

Type700 models a simple steam boiler. According to ASHRAE, a boiler is defined by its overall efficiency (output/input) and by its combustion efficiency ((input energy-stack energy)/input energy). In this model, the boiler efficiency and the combustion efficiency are supplied as inputs to the model. A version of this component also exists (Type751) in which boiler and combustion efficiency are read as a function of entering liquid temperature and device part load ratio from an external data file. This component (Type700) assumes that device efficiency is not a function of inlet conditions.

## TYPE 751: SIMPLE BOILER WITH EFFICIENCY FROM DATA FILE

Type751 models a simple steam boiler. According to ASHRAE, a boiler is defined by its overall efficiency (output/input) and by its combustion efficiency ((input energy-stack energy)/input energy). In this model, the boiler efficiency and the combustion efficiency are read from an external data file in which they are provided as a function of entering liquid temperature and device part load ratio. A version of this component exists (Type700) in which the combustion and boiler efficiency values are specified as inputs to the model instead of in an external data file.

## TYPE 752: SIMPLE COOLING COIL

Type752 models a cooling coil using a bypass fraction approach. A user-defined fraction of the inlet air stream is assumed to reach the average temperature of the liquid filled coils of the device while the remaining fraction is assumed to completely bypass the effects of the coil. The two air streams then mix back together and the outlet conditions are calculated. The

Type752 cooling coil differs from other cooling coil models in that it does not treat the liquid side of the system at all. It is assumed that the coil is not constrained by the liquid side or in other words, that the liquid side can absorb as much energy from the air side as needed. Type752 can be used in three different control modes; in one control mode, the outlet dry bulb temperature of the air stream is maintained at a desired level. In another control mode the air outlet humidity (whether relative humidity or absolute humidity ratio) is maintained at a desired level. In the third control strategy both temperature and humidity are maintained at desired levels. This cooling coil model is not designed to be used in a free float mode because nothing is known about the conditions of liquid entering the device. The model reports the amount of energy removed from the air stream and (if both temperature and humidity are controlled) the amount of reheat energy required to bring the temperature back up to the desired level after meeting the humidity requirement.

## TYPE 753: HEATING COIL WITH VARIOUS CONTROL MODES

Type753 models a heating coil using one of three control modes. The heating coil is modeled using a bypass approach in which the user specifies a fraction of the air stream that bypasses the coil. The remainder of the air stream is assumed to exit the coil at the average temperature of the fluid in the coil. The air stream passing through the coil is then remixed with the air stream that bypassed the coil. In its unrestrained (uncontrolled) mode of operation, the coil heats the air stream as much as possible given the inlet conditions of both the air and the fluid streams. The model is alternatively able to internally bypass air around the coil so as to maintain the outlet air dry bulb temperature above a user specified minimum, or to maintain the fluid outlet temperature above a user specified minimum.

## TYPE 754: HEATER / HUMIDIFIER

Type754 models a device that can heat and / or humidify an air stream. Depending upon the device control mode, the outlet air stream dry bulb temperature, dry bulb temperature and relative humidity, dry bulb temperature and humidity ratio, or humidity ratio only will be maintained by the device. Type754 is not capacity limited but reports the sensible and latent energy required to meet the requested outlet condition based on the air inlet conditions.

## TYPE 756: RESIDENTIAL COOLING COIL (AIR CONDITIONER) WITH UNIFIED DATA FORMAT

Type756 models a residential cooling coil, more commonly known as a residential air conditioner. It relies on catalog data provided in an external text file to determine coil performance. An example data file and information on data file format are provided. This component is functionally identical to the Type651 residential cooling coil except that Type651 requires a different data file format. Depending upon the source of data, this component or Type651 may be the more appropriate version.

## TYPE 757: INDIRECT EVAPORATIVE COOLER

Type757 models an evaporative cooling device for which the user supplies the inlet air conditions of a primary and secondary air stream and the device effectiveness as a function of primary stream inlet air dry bulb temperature and secondary stream inlet air wet bulb temperature. The model calculates outlet air conditions and assumes that the secondary air stream process is a constant wet bulb temperature process meaning that air enters and exits at the same wet bulb temperature. The device is not equipped with controls that monitor the conditions of the outlet air. When the device is ON (based on a user supplied control signal value), Type757 cools the primary air stream as much as it can given the entering conditions and the device effectiveness.

## TYPE 760: AIR TO AIR SENSIBLE HEAT EXCHANGER (HEAT WHEEL)

Type760 uses an effectiveness – minimum capacitance approach to model an air to air heat exchanger that transfers only sensible energy. If moisture transfer as well as sensible energy transfer between the exhaust and fresh air streams is important, Type667 (an air to air heat recovery device) uses similar principals to this model but also accounts for moisture transfer between the air streams. Type760 includes five different control modes. In the first of these control modes, the outlet temperatures of the two air streams are completely uncontrolled. In the other four operation modes, the temperature of either the fresh or exhaust air streams is maintained either above or below a user defined set point.