# The Book of AERMEC

# NRL Sequence of Operation

Heating and cooling operation.

Aermec air to water chiller/heat pump use Hydronic's in conjunction with refrigerant to provide heating and or cooling. The user selects a water temperature set point they desire using the on board or remote controller and the Aermec unit operates to meet this setting. In cooling this temperature may be between 39°F and 64°F while in heating the range is between 68°F and 131°F. If a lower temperature is required in cooling the optional DCPX kit must be installed allowing temperatures between 21° F and 64°F

In heat pump mode. The unit can be started with water as low as 39°F (4°C) and with lower temperature with glycol in the system. The unit will start and if the water volume in the system is correct it will bring the temperature up to above 68F or 20C within approximately 15 minutes. You could see up to three pre-alarms during this time. If the system cannot get up to the required minimum temperature after that it will lock out and need to be reset on full alarm. If the system water volume is very large a bypass is suggested in order to let the unit warm up the water in steps. Do not reset full alarm more than once without checking to see if compressor is running in reverse, or other possible issues.

Example, the controller is set to provide 45°F water to satisfy the load in cooling and a ΔT is also selected (between 5.4°F and 18°F). The temperature is read via the inlet and outlet water sensors and if the temperature is above the desired ΔT the controller will start the sequence of operation required to lower the water temperature to the desired setting. The system pump if in standby mode will start and circulate water through the system. The pump operates for 3 minutes before allowing the compressors to start. If there is low flow the system will shut down on FL or low flow error. Compressors are started one by one approximately 3 seconds apart. If the load can be satisfied not all compressors will start. In the refrigerant to water heat exchanger the water is cooled by the refrigerant. As the water approaches its desired temperature (45° F in this case) compressors start shutting off one at a time. When the desired setting is reached all compressors and fan motors are off. The pump will continue to run if in constant operating mode or shut off if it has been programmed this way. Note: When the next cycle starts a different compressor will start first, this ensures equal operating time for all compressors over the lifetime of the unit.

In heating mode the system works in reverse to provide hot water but the sequence of operation is the same until we go into defrost mode. Defrost mode only occurs when the unit is in heating mode. A detailed description of the NRL defrost is available on the last page of this document.

**Options** Aermec offer many options to our chillers/heat pumps. One such option is free cooling. The free cooling chiller works identically to the chiller mentioned above when the outdoor ambient air is warmer than the desired return water temperatures.
**Free Cooling Example:** 45°F supply water with a ΔT of 10°F which provides for a 55°F return water temperature. Chiller operates as a standard chiller as long as the outdoor ambient air temperature is 52°F or above. When the outdoor ambient drops to 51°F or 4°F below outdoor ambient the factory installed 3 way valve opens and directs the water to the optional free cooling water coils. At the same time the fans go to high speed. The water gives up some of its heat through these water coils and then goes through the refrigerant to water heat exchanger where it is cooled to the desired temperature. We have some free cooling along with mechanical cooling at this point. As the outdoor ambient continues to drop we gain more free cooling and use less mechanical cooling. The chiller will

automatically start shutting off compressors as they the temperature drops and they are not required. Eventually when the temperature drops low enough the mechanical cooling is not needed at all and we are using entirely free cooling. The exact temperature that we reach 100% free cooling at depends on the return water temperature but in this example we would each 100% free cooling at approximately 29°F. The savings are tremendous and this unique free cooling system is real advantage. The system is fully automated. In applications where the chilled water temperature required is higher e.g.: 55°F so the return water is 65°F free cooling would start at 61°F providing even greater savings. Aermec also provide solenoid valves in the refrigerant condensers that allow us to operate our fans at high speed (moving more cold air across the coils) as soon as we go into free cooling. This maximizes our energy savings and allows for TOTAL free cooling at higher temperatures than our competitors as they slow their fans down to control the refrigerant head pressure and thus have less energy savings at all temperatures once they have entered free cooling mode.

**Heat recovery**

Another popular option Aermec offer is heat recovery. The heat recovery is available as a de-superheater option or 100% heat recovery option. **Desuperheater:** The desuperheater operation operates in the following fashion. When the chiller or heat pump is in cooling mode and there is a call for heat recovery, we can have heat recovery. The refrigerant passes through the de-superheater heat exchangers of on its way to the condenser coils. A field installed pump is started by a thermostat or sensor located in a remote field installed storage tank. When the pump starts it pumps water through the heat recovery heat exchangers and picks up the free heat. This heat is transferred to the storage tank for use in the building or load.

When the storage tank is satisfied the pump shuts down and the heat recovery cycle ends. The unit continues to operate as a standard chiller until the next call for heat recovery. With the desuperheater option the refrigerant always passes through the de-superheater coils and the pump triggers the recovery..

**100% Heat Recovery:** The 100% heat recovery operation operates in the following fashion. It is different from de-superheater in that it has larger heat exchangers, three way valves that open and close the operation based on demand, it is an on demand system.
When the chiller or heat pump is in ***cooling mode*** and there is a call for heat recovery, we can have heat recovery. When there is no demand for heat recovery the refrigerant BYPASSES the heat recovery heat exchangers of on its way to the condenser coils. On a call for heat recovery a field installed pump is started by a thermostat or sensor located in a remote field installed storage tank and the solenoid valves are actuated directing the refrigerant through the heat exchanger coils. At the same time water is being pumped through the heat recovery heat exchangers and picks up the free heat. This heat is transferred to the storage tank for use in the building or load. When the storage tank is satisfied the pump shuts down, the solenoid valves close and the heat recovery cycle ends. The unit continues to operate as a standard chiller until the next call for heat recovery. With the 100% heat recovery option the refrigerant passes through the heat exchanger coils only when there is a call for heat recovery. This is more efficient than passing the refrigerant through the coils when not required due to the fact that the heat recovery exchangers are so much larger than the de-superheater heat exchangers. The control of heat recovery is the cooling mode. We can only have heat recovery when we are operating in cooling.

The minimum run time for heat recovery is 10 minutes and we may set a cold water and hot water set point.

**Water volume constant or variable:** Running the units with constant water volume is the easiest to control the system and allows trouble free operation. If you calculate constant volume based on maximum energy transfer and allowable ΔT in the Aermec, the unit will operate well in all operating modes. The capacity of the chiller / heat pump is more a function of outside air temperature than anything else.

If ***variable flow*** is desired it can be accomplished by adding a flow balancing valve. This will keep a constant flow through the chiller / heat pump while allowing variable flow through the building or load. Please contact your factory report for design considerations when specifying variable flow.

**Low water temperatures in heating mode:** Low water temperatures from the building during start up will be an issue when using the heat pump in heating mode if not handled properly. To solve low water temperature issue we require mixing in the water loop. In this case mixing some hot HP output water back to the HP input stream makes sense. The water should be kept at or above 68°F. It does not significantly affect the total energy transfer or capacity. Thinking of the system in terms of BTU's instead of temperatures really helps.

**Defrost** Before we can enter any defrost, we must reach a low pressure minimum value. Only when the low pressure is below 61 PSI can we possibly go into defrost. If the pressure is above 61 PSI, we have no chance of needing defrost as the coils are not frosted or blocked. Only after the pressure drops below 61 PSI for more than 10 minutes will we enter a possible defrost situation. If we reach these two conditions, we can have a defrost minimum every 30 minutes according to this parameter. (Below 61 PSI for more than 10 minutes)

The sequence of operation logic states that after 5 minutes of compressor operation (allowing pressures to stabilize) we read the low pressure and write it to memory inside the controller, this becomes fixed value A. After that if the low pressure drops more than 8.7 PSI below the fixed value A, we can have defrost. The defrost is accomplished by reversing the cycle. The t t sbr parameter is the delay time between two defrosts which is 1800 seconds.

So, after the unit has started and the compressor has run for 30 minutes, we read the low pressure and this is our value. When the pressure drops down more than this differential, 8.7 PSI the defrost is started if we have had a minimum of 30 minutes since the last defrost. When the defrost is called for we stop the compressor(s), reverse the four-way valve and start the cooling mode while stopping the fan. We stop the defrost by time or temperature, with the minimum time being one and one-half minutes and the maximum time being 6 minutes. So, we can stop the defrost by the maximum time or when the liquid sensor on the liquid line before the expansion valve reads 20 degrees C or 68 F.

When we have tandem or 3 compressors every time that one compressor starts or stops, we automatically recalculate the delta p. There is a parameter inside the reading menu where you can see the exact delta p. This allows you to see how many PSI of pressure drop we must wait to enable the defrost. If you go into the menu through the display, there is a parameter that is reading the countdown of low pressure drops (it must be zero to authorize the defrost).

We must also consider that the unit may have two circuits. The first circuit that arrives at 8.7 PSI below the fixed value calls the defrost but we have only one fan group so when the first circuit calls for defrost it automatically stops the second circuit.

When we have two circuits that are running and the first circuit or number one calls the defrost, we stop the compressor on the second circuit. We perform the defrost on the first circuit and then both circuits come back up in heating mode. This is due to having only one fan group. When we have two fan groups in the larger heat pumps they work independently. A circuit can start and stop its own defrost. For the smaller models where we have only one fan group it is necessary to stop the second circuit to defrost one circuit. If you want to accelerate the defrost due to a unique installation, you can adjust the parameter. This may be due to different working conditions, or an area where the humidity is very high and the temperature becomes very low. A faster defrost may be required because otherwise if the low pressure never drops down, it will never defrost, it cannot defrost. This is only through a reversing valve, no injection.

The defrost is also called if after 30 minutes of compressor run time (times=0) but the delta low pressure is not reached and the LP is < 58 PSI (extreme working condition) The 30 minutes are cumulative so if during the functioning compressors are stopped, we will consider the 30 min like real working time. When the compressor is stopped (it reached set point) at the next start up it must operate a minimum 10 minutes before it is able to enter defrost, of course if all conditions are satisfied. The advantage of this system is that is auto adaptable at all working conditions and defrost is called only when the heat pump is losing significant performance.