Overview

The CGC Group BULLDOG Heat Pump System does **NOT** operate with the same fluid loop temperatures as a conventional reversing Water Source Heat Pump system. The CGC system differs from a WSHP system in that it does not operate the compressor in the heating mode. Instead, each CGC unit has a hot water heating coil to provide heating. As with most hydronic heating systems, the supply fluid temperatures are increased as the outside ambient conditions get colder.

The BULLDOG loop temperature is maintained at 85°F (29.4°C) when ambient conditions are above 55°F(13°C). This will allow any CGC unit to deliver a minimum of 30% of its rated heating capacity. As ambient conditions fall below 55°F (13°C),the fluid loop temperatures are increased. The standard rate of increase is 1°F rise in fluid loop temperature for every 2°F drop in ambient temperature. At this rate, the fluid loop temperature would be 108.5°F (42.5°C) at 8°F (-13°C) ambient conditions.
One of the advantages of the CGC system is that the heating output can be scheduled to the actual load. For example, in intermediate seasons, when full heating output is not required, the fluid loop temperature will be scheduled to only deliver the required amount of heat output. This is different than a reversing WSHP that provides full compressor heat regardless of how much heat output is actually required.
The CGC Group offers a prepackaged system controller that is custom programmed to accommodate most system arrangements. The CGC system controller is BACnet based and can be integrated into most BAS.

Controls by Others

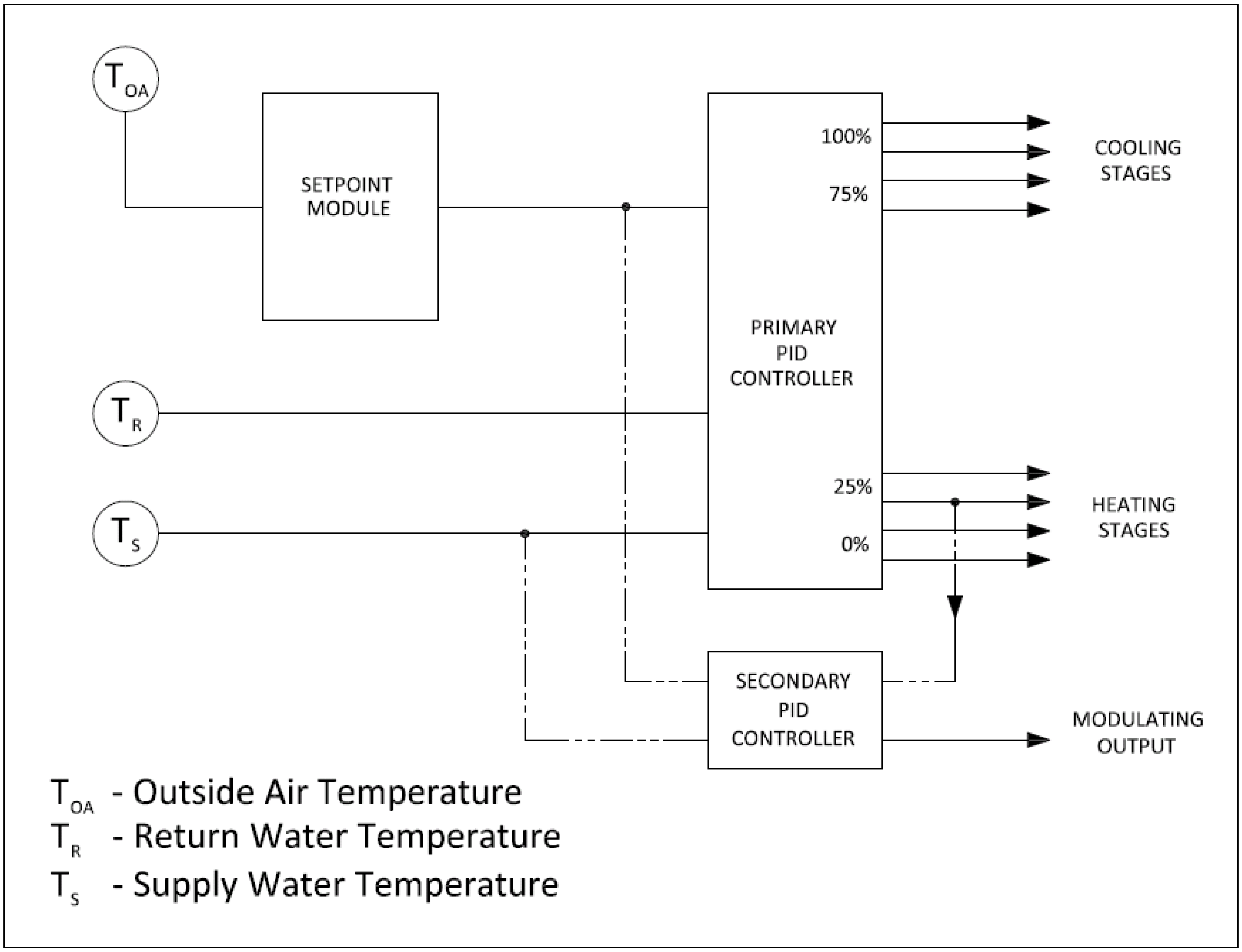
Should a third party controller be selected, it must be programmed to provide the functions required by the system. These functions include maintaining both adequate flow rates and the scheduled loop temperatures. We recommend the following algorithms be included.

Pumping

Architecturally, CGC strongly recommends that the system pumps have full standby. On smaller systems, CGC recommends that two pumps each sized to provide 100% flow be installed. On larger systems, a three pump arrangement each of 50% capacity could be considered, with two pumps operating at all times. With a two pump arrangement we recommend that one operate for the first ½ of the month, and the second be used for last half of the month. Similarly, on a three pump installation, each pump be shut down for a period of 10 days per month. On pump rotation allow a 10 second delay before starting up new pump. Variable flow systems can also be utilized with the addition of unit mounted flow controls, but this is discussed in an additional bulletin.
Pump flow shall be monitored by the control panel. CGC recommends that Pressure Differential switches be utilized to provide flow monitoring rather than paddle type flow switches. PD switches are more reliable, do not require system drainage for repair, and are not affected by turbulent flow. A two pump system will require one pressure differential switch installed across the supply and return headers. The three pump arrangement will require three pressure differential switches, which must be installed across each individual pump. The control panel shall command one or more pumps ON in accordance with the above schedule. However, should the flow monitor detect a flow failure that exceeds 15 seconds, the panel shall shut down the malfunctioning pump and immediately start up the standby pump. This pump shall be operated continuously whether or not the flow sensor is satisfied, until the algorithm is manually reset. Simultaneously a flow failure alarm shall be sounded.

Temperature Control (Set Point)

In order to optimize the performance of the FreeHeat system, the temperature of the fluids supplied to the units must be accurately controlled. CGC has developed a series of control algorithms that best satisfy the needs of the system. Three accurate temperature sensors are required. The outside air sensor must be mounted outdoors on a surface that is not ever exposed to the sun. This sensor must be located where it will not be influenced by heat transmission through the walls, exhaust air streams, or nearby heat producing equipment. System return fluid and supply fluid sensors must be installed on the piping where they will not be compromised by cold outdoor air, boiler vents, unit heaters, etc.

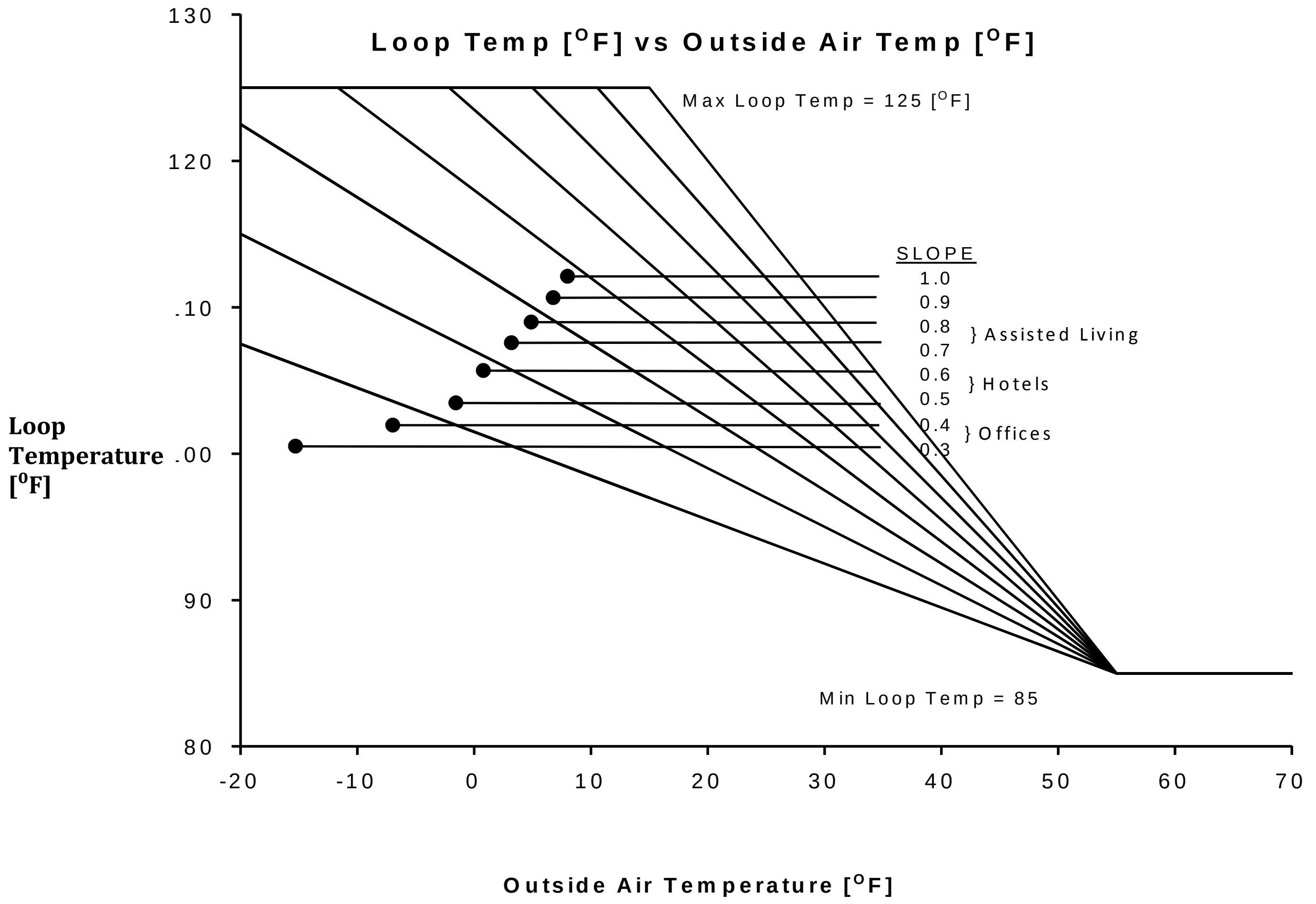


(Note: This is a General Schematic Drawing)

Advanced Features

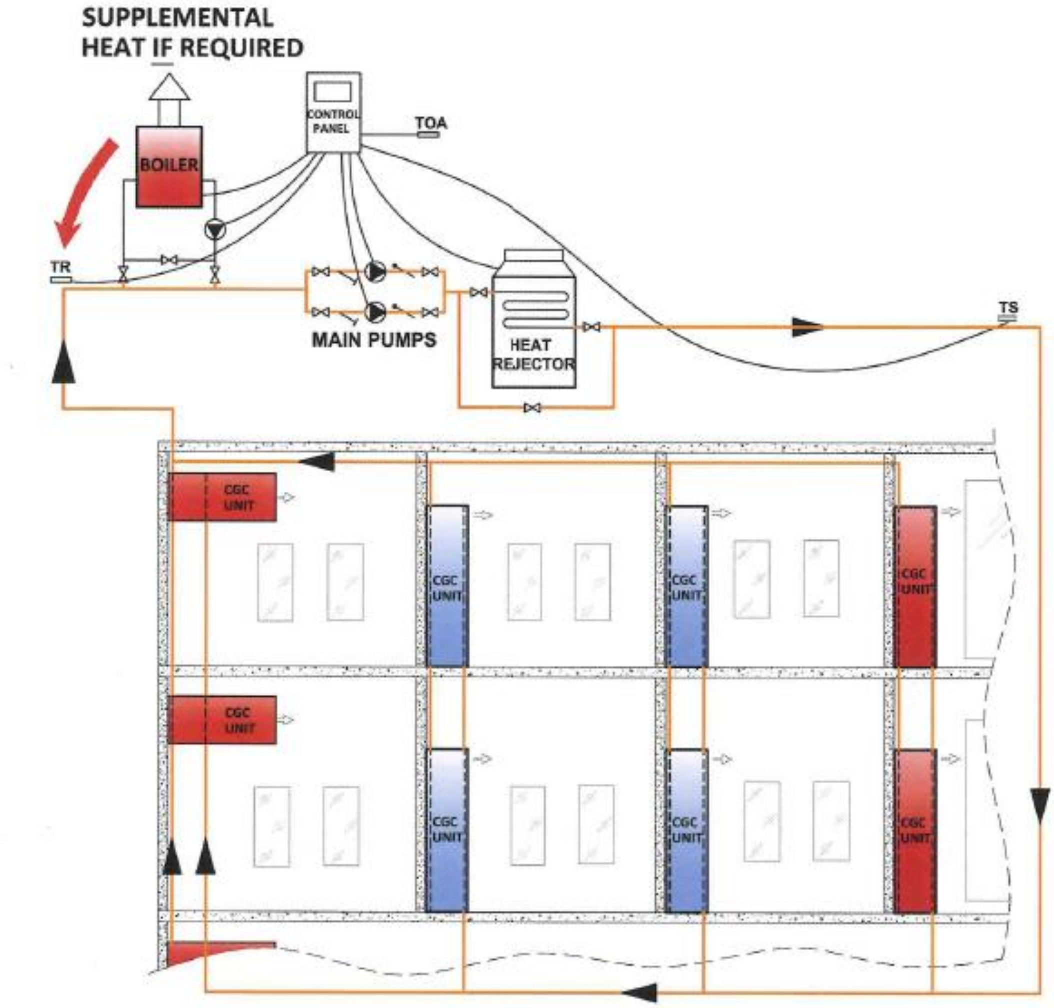
Modulating equipment such as valves or modulating boilers are best controlled from discharge temperature **Ts**. Systems with both step control and modulating control should be controlled via the same primary PID output control for the staged outputs with $\mathbf{T_R}$ as the variable input; but with the addition of a second PID control algorithm that is enabled as a step from the primary PID. This secondary PID will use the same set point as the primary PID, but the temperature input variable will be from the discharge fluid temperature sensor **Ts**. With this arrangement the discharge temperature control will only function when enabled by the primary PID control. Overshooting and cycling will be prevented. However, if staging is not required for either heat injection or heat rejection (no steps on heat input or heat rejection), the primary control sensor should be switched to the supply fluid temperature sensor **Ts** and the second PID algorithm will not be required.

The reset rate is adjusted to maximize performance. Lower reset rates increase cooling efficiency but reduce the heating capacity.



The **system fluid set point** is similar to that for a hot water heating system with the following control logic:

- Ambient 55°F (13°C) and above - hold 85°F (29.4°C) fluid temperatures.
- Ambient below 55°F (13°C) – The fluid set point will be reset downward by the following equation.
  85°F + [Reset rate X no. degrees below 55°F]
  - I.e. ambient of 32°F (0°C) and rest rate of 0.5 .
  - Fluid set point= 85°F +[0.5(55-32)]= 96.5°F
- Nominal reset range .25 to .75
- Maximum fluid set point temperature 125°F (52°C)



Temperature Control (Output)

Reversing WSHP systems commonly control the operation of the fluid coolers and boilers from the discharge fluid temperature. This control system however may cause excessive cycling .For staged controlled systems, CGC recommends that the system be controlled from the return fluid temperature sensor in order to maintain system stability.

The standard system control algorithms are PID based and arranged as follows:

- Primary control is from the return sensor monitoring fluid temperatures returning from the heat pump units.
- PID inputs for primary control are Set Point and Return Fluid Temperature $T_{R,}$ is the process variable
- Output for primary control is 0% to 100% over a 20°F change in temperature (or equivalent)
- PID integral reset value 10% of offset per minute
- 1st stage of Heat Injection is enabled at 25% PID output, 2nd stage and beyond are spread out between 25% and 0%. Each stage is disabled at 10% higher value. i.e.: 1st stage disabled at 35%
- 1st stage of Heat Rejection is enabled at 75% PID output, 2nd stage and beyond are spread out between 75% and 100%. Each stage is disabled at 10% lower value. i.e.: 1st stage disabled at 65%
- 5 Minute inter stage delays should be incorporated into the ON staging only