App Note BACNet HVAC Example

Figure 1 shows the components, plumbing and directional information of a standard induced draft counter flow cooling tower.

The red is the heated water that the chiller needs cooled, and the blue is the cooled water supply to the chiller. The PLC has 4 temperature sensors that are read by the 2080sc-NTC in slot 2, and a humidity sensor that is read by the first channel of a 2080sc-IF4U in slot 3. The PLC also controls 2 sets of valves (VLV1 & VLV2) to use waste heat in the cooler months to raise the floor temperature and use cooling tower supply water to cool the floor in the warmer months. To manipulate the temperature of the floor one of the valve sets is closed. If there is no energy advantage to adjusting the floor temperature, both valve sets are open. If there is an error or failure with a valve set, they are designed to fail at the last position and drift open (FL/DO). Open means that the fluid flows past the valves directly between the chiller and the tower with no diversion through the floor. The last components are the 2 variable speed drives. M1 (Tower_CTWP) pumps the water that the chiller needs cooled to the tower, and M2 (Tower_FAN) drives the fan.

The way an induced draft counter flow cooling tower works is that water is pumped to a basin on the top of the tower where gravity allows the water to flow through distribution holes. There is a low resistance air intake on the sides of the tower and the fan pulls air through the falling water and up out of the tower. The sides shield the interior from sunlight to retard algae growth which reduces the amount of algae control chemicals required.

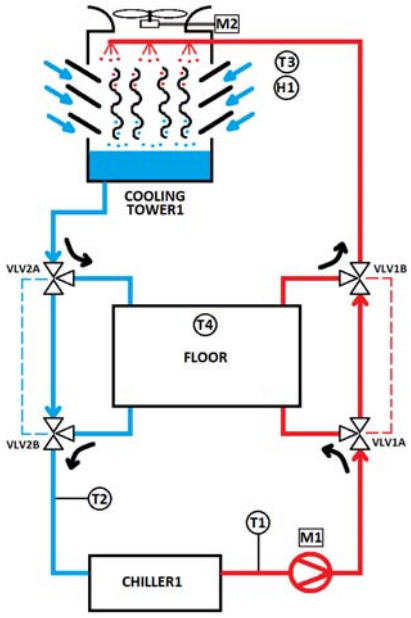

Figure 1 - standard induced draft counter flow cooling tower

The PLC program for this cooling tower illustration is an example and does not have the entire set of controls that a fully functional cooling tower control system would have because it is designed to be simple to understand, yet functional. This tower would be part of a facility that provides chilled process water to a variety of equipment such as air handling units, autoclaves, machine tools and presses and there might be multiple sets of these chiller / cooling tower systems placed in various buildings across the facility.

In this example, Chiller1 calls for cooling water through a digital input to the PLC. If the tower is in AUTO, the PLC continuously monitors T1 – T3 and H1 to calculate how to run M1 and M2 to optimize pump and fan speed to most efficiently bring the temperature of T1 as close to T2 as required to satisfy the chiller, while minimizing the operating cost. If the tower is in HAND, the operator local to the tower can place either or both M1 and M2 into HAND to allow the replacement of a failed sensor, for instance. The motor placed in HAND can be run at a fixed speed.

The PLC in this illustration has a 2080sc-BAC module in slot 1. This allows the cooling tower control PLC to be controlled by (is an accessory of) the Building Automation System (BAS) when the tower is placed in AUTO. The Building Automation System controls every building in the entire facility, and tries to balance the usage of energy to do the daily work of the facility with the time of day cost of energy purchase at each location. The cooling tower controlled by the PLC in this illustration is only one of many elements in this facility, and this facility is only one of many in the corporation – the others are spread across the country. If this is facility 17 and this cooling tower is in building 10 then to the BAS, this cooling tower might be designated as 17-10-CT1.

From the Building Automation System's point of view, the devices it controls in the PLC when the tower is in AUTO are outputs. The list of outputs includes the analog values: temperature setpoint, which guides the PLC in how to supply cooled water to the chiller, the fan speed and the pump speed; and the digital values: floor temperature control enable and whether to heat or cool the floor. The BAS also reads inputs from the PLC. The analog values: chiller, tower, floor and ambient temperature and relative humidity; and the digital values: Chiller and tower fault status, whether the area is occupied, and the HAND/OFF/AUTO status of the tower. The Building Automation System inputs and outputs are mapped to registers in the PLC by the 2080sc-BAC module in slot 1. The PLC sees the BAS outputs as inputs to its process, and the PLC outputs are inputs to the BAS.