Establishing Minimum Hydronic System Flow

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There are many considerations when attempting to establish minimum system flow in a variable flow primary pumping hydronic system:

- The flow required at coils served by three-way control valves.
- The flow required at end-of-circuit recirculation bypass valves.
- The minimum flow required for boilers in a heating system.
- The minimum flow required for chillers in a chilled water system.

The flow required at three-way control valves can be totaled from the design documents. The design flow for any end-of-circuit recirculation valves should also be specified in the design documents.

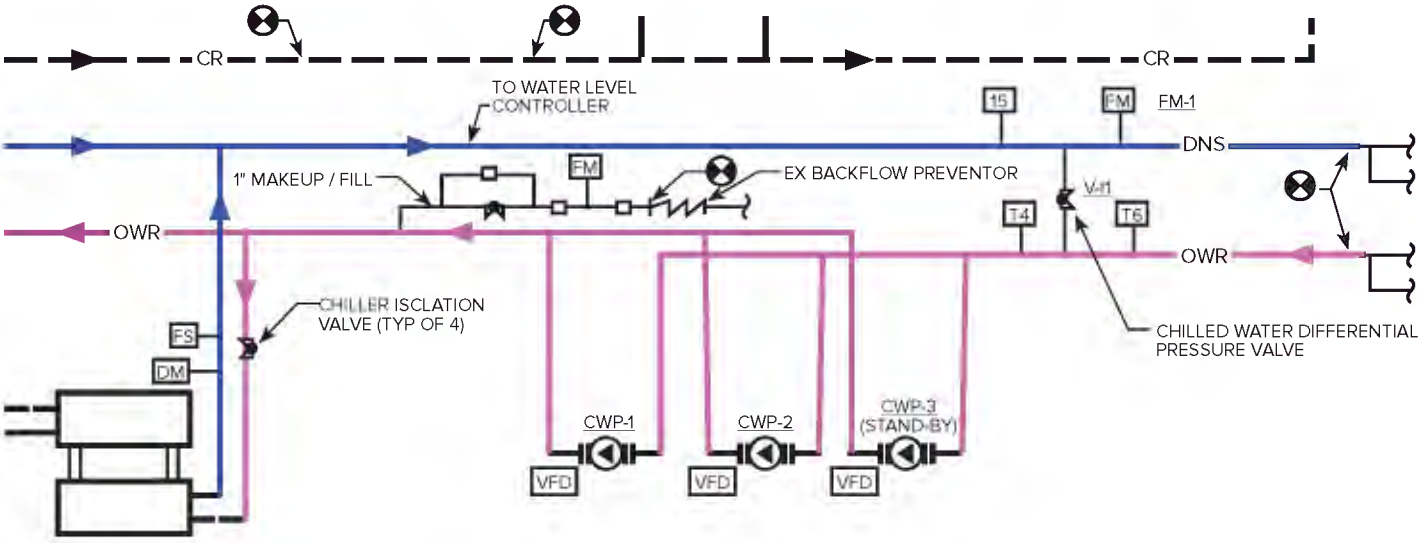
Minimum flow for boilers or chillers would generally be gleaned from the equipment submittal data or other manufacturers' available data. If the boiler or chiller minimum required flow is higher than what is totaled from the coils with three-way valves and the end-of-circuit recirculation valves, then a minimum flow bypass circuit is normally installed. The ideal configuration for precise minimum flow control would be a properly located flow meter.

The diagram on the next page of a chilled water system shows an improperly located flow meter downstream of the differential bypass valve. In the depiction (taken from an actual project), as the bypass valve would open, the flow as measured at the flow meter would continue to drop. Fortunately, on this project the installing contractor installed the flow meter in the correct location so that it was capable of being used for minimum flow control.

This particular project also had the following verbiage in the control sequence:

"Differential pressure sensors (DPS-1, DPS-2, DPS-3) shall control the pump variable frequency drives (VFD) to maintain system differential pressure setpoint controlled by the pressure differential. Differential pressure setpoint (DPS) to be field determined by the testing & balancing contractor. Should VFD's reach minimum turndown speed, DPS shall modulate differential pressure valve to maintain a differential pressure set point."

Establishing the operating system differential setpoint as stated above is normal operating procedure for testing & balancing professionals. Nowhere in the sequence above, however, is minimum flow for the equipment (chiller in this



case) referenced, which became an issue on this project since we had a variable primary system. The differential pressure bypass was used in conjunction with the flow meter to control minimum flow as required for the chiller.

Initially, the design team and existing building operational personnel assumed that minimum flow was directly related to pump operating speed. However, as all test & balancing professionals are aware, on a pressure-dependent system, pump speed and flow are not necessarily related without knowing the positions of the two-way control valves in the system. Just because a pump is operating at a high speed does not mean we would have flow. In simple terms, a pump operating at 60 Hz (high speed) with control valves closed equals no flow.

Lastly, we note the verbiage "minimum turndown speed." In my opinion "minimum turndown speed" is a function of the motor and pump. The minimum speed should be specified by either the motor and/or pump manufacturer and be set up by the VFD startup technician. Generally, "minimum turndown speed" for a motor would be related to its ability to stay below its maximum operating temperature depending on the type of motor that is installed. "Minimum turndown speed" as related to pumps is generally a function of maintaining a minimum flow to protect the seal from premature failure. Several pump manufacturers recommend a minimum operating speed of 25 percent, 15 Hz for a pump operating at 60 Hz maximum speed.