

## Back-up Evaporator Pump Addition Outline Operating Sequence

The purpose of this outline sequence is to provide an indication of the programming requirements and level of effort associated with the addition of CHWP-5 to the existing central plant system and incorporate it into the control logic for the plant. Final details and logic diagrams will be developed in concert with the control contractor during the submittal review process.

### Overview

The current staging arrangement for the plant shall be retained; i.e. in general, VFD/hot gas bypass equipped chiller 2 shall be the lead machine at all times. Chiller 1 shall be brought on line when additional capacity is needed or if Chiller 2 fails. For additional details regarding this sequence, see the modified control drawings associated with the November 2015 control sequence improvements project.

The modifications associated with this project involve making the new, more efficient evaporator pump CHWP-5 the lead pump, associated with the operation of the lead chiller (Chiller 2). Existing pump CHWP-2, the pump currently associated with Chiller 2 will become the back-up pump. And existing pump CHWP-1, associated with the lag chiller (Chiller 1) shall be retained for use with CH-1 but will have its efficiency improved via an impeller trim.

CHWP-1 shall also have its triple duty valve replaced with a butterfly service valve/throttling valve and a wafer check valve to allow the check valve to be isolated and serviced with-out a chiller outage and to eliminate the wide open pressure drop associated with the triple duty valve setting following the impeller trim.

The manual service valves connecting CHWP-5 with the discharge connections on CHWP-1 and 2 shall be positioned with the connection to the CHWP-2 discharge open and the connection to the discharge of CHWP-1 closed. This will allow CHWP-2 to automatically come on line and back-up CHWP-5 in if it fails.

But it is also possible to have CHWP-5 back-up CHWP-1 by reversing the position of the manual valves. This option is initiated manually and when it happens, CHWP-5 is operated in place of CHWP-1 to support Chiller 2 and CHWP-2 supports Chiller 2.

The control system graphics shall include a graphic push button that can be used in conjunction with the manual valve position changes to modify the control sequence so that the failed CHWP-1 is taken out of the automation sequence, CHWP-5 is associated with the operation of Chiller 1 and CHWP-2 is associated with the operation of Chiller 2.

See the system diagram for additional clarification.

### Revised Plant Staging

Make the following revisions to the existing plant operating sequence.

1. Associate the operation of CHWP-5 with the operation of Chiller 2, including being the start trigger for the chiller run cycle (CHWP-5 is started to initiate the start sequence for the Chiller 2 system) and the off-delay on shut down (CHWP-5 remains in operation after Chiller 2 shuts down for an adjustable 2 minute delay to maintain flow through the evaporator while the compressor spins down).
2. If CHWP-5 fails, replace it with CHWP-2 in the automation sequence. CHWP-5 shall be defined as having failed if it is commanded on and its proof of operation point opens up, indicating it is not running even though it is commanded on.

Note that when an event such as this happens, Chiller 2 will be tripped out and locked out due to other safeties like the flow switch interlock and will require a manual reset to resume normal operation. But the intent of this sequence is that once Chiller 2 is manually reset, CHWP-2 will take on the role of CHWP-5 and allow the plant to continue to run in an automated manner while the reason for the failure of CHWP-5 is identified and addressed.

3. Provide a graphic push button that can be used to reset the logic to use CHWP-5 with Chiller 2 via an operator interaction once any issues are resolved.
4. Provide a note with the CHWP-5 logic reset push-button indicating that prior to resetting the logic, the plant should be put through a normal shut down via the existing plant disable graphic push button. Then CHWP-5 should be reset, and then the plant should be allowed to resume normal automated operation via the plant enable graphic.
5. Provide a graphic switch that can be used by the operators to:
  - a. Associate the operation of pump CHWP-5 with the operation of Chiller 1 instead of the operation of Chiller 2 and
  - b. Associate the operation of pump CHWP 2 with the operation of Chiller 2 instead of standby status

for situations where CHWP-1 has failed and the operators have manually valved the system to allow CHWP-5 to serve Chiller 1 and CHWP-2 to serve Chiller 2.

6. Provide a note with the CHWP-5 graphic selector switch indicating that prior to changing it's state, the plant should be put through a normal shut down via the existing plant disable graphic push button. Then the switch should be moved to associated CHWP-2 with the desired chiller, and then the plant should be allowed to resume normal automated operation via the plant enable graphic.
7. Provide hours and energy monitoring and accumulation for the new pump per the notes on the point list and coordinate this information with the existing graphics and database containing the hours and energy information for the other items of equipment in the plant.
8. Update all graphics, reports, trends and other control system software to reflect the addition of the new pump and its related control system hardware and software.

#### Pump Start/Stop Control

Coordinate with the electrician to ensure that the starter they furnish includes a Hand-Off-Auto switch (HOA) and a Push to Test type LED red pilot light.

When the HOA is in the "Off" position, the pump shall not operate and the pilot light shall be off.

When the HOA switch is in the "Hand" position, the pump shall run continuously regardless of the status of the output from the control system associated with it and the pilot light shall be on.

When the HOA switch is in the "Auto" position, the pump shall run per the automation sequence as described above.