Central Chilled Water Plant Preliminary Findings List

	Finding or Opportunity	Obvious Indicator	Associated Scenes	Savings: Energy Savings	Savings: Other Resource Savings	Non-resource Benefit: Cleaner	Non-resource Benefit: Safer	Non-resource Benefit: Comfort	Non-resource Benefit: Productivity	Non-resource Benefit: Performance	Potential low cost/no cost	Next Step	Precautions/Considerations
1.	The discharge valves are throttled on the evaporator pumps.	The triple duty valves are not fully open (around 40%).	5, 35, 40-42	X							X	You could get a sense of the savings potential right there in the field by looking up the triple dute valve performance curve on your phone and then using the pump power equation to estimate savings based on the design flow (Scene 40-42, about 12	A pump test will further quantify your estimate and it is important to remember that there are multiple ways to optimize the pump including an impeller trim, a VFD, or even a new pump. Your job is to pick the best one for the current situation.
2.	The discharge valves are throttled on the distribution pumps.	The triple duty valves are not fully open (around 40%).	3, 36	X							X	Ditto item 1. Plus, this savings could be quickly achieved by simply opening the valves and allowing the VFD to do its job.	In a utility program, you would want to document the existing condition before you open the valve. Otherwise, you might not get the incentive (but you will get the savings). Also, you should make sure that there really is a control process in place that will slow the pump down if you open the
3.	The shot feeder valves are open.	The shot feeder is piped across one of the distribution pumps, thus has a large differential pressure across it and the service valves are open.	19, 20	X							X	Closing one of the service valves is all that you need to do. You may want to isolate and drain the shot feeder if you are worried about having stagnant water sitting in it.	Make sure that isolating the shot feeder does not impact other water treatment equipment like a coupon rack or a sensor of some sort. Unlike the shot feeder, a coupon rack or a TDS or pH sensor will need continuous flow to do its job.
4.	Evaporator pump CHWP2 is in Hand	The position of the Hand-Off-Auto (HOA) selector switch.	33	X	X						X	Returning the system to Auto has the potential to save energy but how much will depend on the climate and on the chiller staging sequence.	Before putting the pump back in Auto, it would be a good plan to try to undestand why someone put it in Hand in the first place. There could be a reason and a related issue that you need to address first to avoid a problem and/or prevent someone from putting it back in Hand right away.
5.	Both distribution pumps are running under a condition when one pump could handle the load.	The estimated load condition on the chiller along with pump physics knowledge	9 - 15, 34, 37, 43	X	X						X	Return the VFDs to auto and modify the control seuqence to only bring on the second pump when the load reaches the point when one pump can no longer meet it.	The same comments regarding returning the evaporator pump to "Auto" applies here.
6.	It may be possible to leverage the 2/3 rule and reduce distribution pump head at part load instead of maintaining a fixed pressure at the headers.	The current operating pressure relative to nameplate and an estimate of the part load pressure drop to a remote mechanical room.	19, 34, 38	X	X						X	Add a differential pressure sensor at an accessible location at a remote point in the system and use this sensor to reset the set point of the distribution pump header differential pressure control loop as needed to based on the remote condition.	Complex systems may merit several remote sensors so you could pick the worst condition to control to. You may be tempted to just move the existing sensor, but that sets up problems related to lags, wiring costs, and open loop operation if the remote sensor is wired to the network
7.	CHWP-3 VFD is in Hand and set for 100%, dead heading the other pump.	Indications on the VFD control panel, knowledge of pump physics, puddle of water under the pump seal.	19, 34, 38	X	X						X	Return the pump to automatic operation. Repair the seal that was damaged by the overheating caused by long term dead-head operation. Performa a pump test to verify the impeller was not damaged by cavitation while deadheaded continuously.	The same comments regarding returning the evaporator pump to "Auto" applies here.
8.	CHWP-3 and 4 appear to have not been aligned in the field and have not had their bases grouted.	Factory paint still on the hold down bolts and shims, no grout in the frame (compare these pumps to CHWP-1 and 2).	37, 38, 31, 32		X						X	Alighn the pumps per the manufacturer's requirements and then grout the bases to help preserve the alignment.	
9.	The make up line to the CHW system is open. A closed system should not require continuous make-up and keeping the valve open risks water damage if a pipe failed.		23-Jan		X		X				X	Add a pressure sensor that monitors the system fill pressure and generates alarms if there is a gradual loss of pressure (minor leak) and shuts down the pumps and chillers and pages the on-call operator if there is a sudden, large loss of pressure	Educate the operating team and get their buy-in for this new operating approach. Closely monitor the system when the valve is first closed to be sure there is not already a leak.
10.	The piping configuration does not match the design intent system diagram. This is related to item 11 and 12 below.	Field verifying the system diagram after noticing a potential conflict between the schematic and the piping plan on the contract documents.	18, 25, 26	X								Document the installed condition in the as built documentation and educate the operating team about the difference and its significance.	Depending on a number of things, including the resolution of items 11 and 12, modifying the piping to achieve the design intent may not be cost effective unless other piping modifications are being made in the plant.
11.	The piping configuration as installed does not allow the full benefit of the chiller selection and staging strategy envisioned by the designer. This is related to item 10 above and item 12 below.	CH-2 has hot gas bypass and a VFD, which implies it has better turn-down capability and a part load kW/ton sweet spot, making it the machine intended for low load by itself and part load when CH-1 is on at	9-15, 18, 29, 30	X	X							Modify the chiller staging software to reflect the installed piping configuration and leverage the capabilities of the chillers including considerations related to items 10 and 12.	The operating sequence used if the piping is not modified will likely be different a bit from what would be used if the piping is modified. Any modifications that are made should include commissioning at start-up and seasonaly to verify and fine tune the new sequence
12.	The chillers appear to be staged for equal run time instead of for the apparent design intent (see item 10 above).	The number of run hours for both machines are roughly equivalent but CH-1 has many, many more starts because when it is the lead machine at low load, it short cycles since it has no hot gas bypass or VFD.	12, 15	X	X						X		The comment above for item 11 applies here also.
13.	Based on the load on the system, the chiller power consumption and the observed temperature rise, the condenser water pump serving chiller 1 may be running out its curve with out the pump associated with chiller 2 in operation.	Using Q=500xgpmxΔt and a heat balance based on the chilled water load, the compressor kW and the observed CW Δt suggests the condenser flow is in the 2,300 - 2,400 gpm range vs. the 1,650 design	8, 9, 12, 18	X							X	Review the condenser pump and cooling tower installation and develop a system diagram. Perform functional testing to further validate and quantify this observation.	The staging of the cooling tower cells will also impact the opeating point of the condenser water pump and will need to be considered for any solution that is developed.
14.	Based on a variety of indicators, the plant has in the range of 300 tons of load on it when other indicators would suggest that there should be little if any load.	Load estimated from the evaporator flow and Δt or the chiller nameplate data; requirements estimated based on the ambient conditions and the coil schedule on the plans and logic. Leads to	9. 12. 18, 30, 31	X	X					X	X	Begin to check out the loads served by the plant to identify the system or systems that are the root cause of the problem.	Addressing this problem will likely push the plant into a new operating envelope that it may have never seen before, in particular a low load condition. This could introduce new operating challenges that will need to be dealt with including the potential for hot gas use or chiller short
15.	The current distribution pump selections seem to be farily low efficiency compared to what might be possible. Estimating the water horse power from the nameplate data comes out at 25 hp, which is significantly below the 40 hp motor capabiltiy.	Knowledge of pump physics and some application experience.	37, 38	X						X		Optimizing the pumping energy by adding a new, best efficiency selection, right sized pump may be a viable option, especially if there are a lot of run hours or the energy rates are high.	There may also be more cost effective options that save almost as much energy with out the expenditures required to add a new pump. However, if a redundant pump is to be added that makes a high efficiency right sized selection very attractive compared to a like for like
16.	The lights are T-12s and seem to be on all of the time because nobody thinks to turn them off.	Visual observation of lamp labeling.	Any	X							X	Consider adding some sort of lighting control strategy and/or upgrading to higher efficiency lamps.	It can be difficult and dangerous to do an occupancy sensor based strategy in a mechanical room. The best strategy may be operator education combined with upgrading lamps and fixtures when the existing lamps burn out and/or when a fixture fails and needs to be replaced.
17.	The plant appears to be in low delta t syndrome; its just not to the point where the 2nd chiller needs to be started to prevent forward flow in the bypass.	System temperature rise vs. chiller temperature drop and the apparent flow rate throught the chiller based on the evaporator pump nameplate and throttled valve	2, 9, 12, 15, 29, 30, 31	X						X		Recognize that the conditoin exists and that it could be due to issues with unrealisticly low AHU LAT set points or valves failed open.	Also realize that because of how chilled water coils work, the systme likely will drive into low delta t under some operating conditions even if nobody makes a mistake. This should be considered when coils are replaced or chillers are added to the system.
18.													
19.													
20.													

Central Chilled Water Plant Preliminary Findings List

	Finding or Opportunity	Obvious Indicator	Associated Scenes	Savings		Non-resource Benefit					Potential low cost/no cost	Next Step	Precautions/Considerations
				Energy Savings	Other Resource Savings	Cleaner	Safer	Comfort	Productivity	Performance			
21.													

Version 1, Friday, June 1, 2018