Systecon®
CINCINNATI, OHIO

Bulletin No. CS-004

CENTRAL PLANT CONVERSION *Case Study*

The central plant at the DuPage County complex consists of approximately 4000 tons of cooling capacity, including a 1.244 million gallon water chilled water storage tank. The central plant is served by a 1000 ton absorption chiller, a 1000 ton electric chiller and a 2000 ton electric chiller.

There are seven buildings served by the chilled water plant. All buildings had three-way control valves with constant speed pumps and return water blending circuits. The buildings are being converted with variable volume two-way control valves. The tank had no temperature control circuit to provide an even temperature drop when the tank was being charged.

The original design was a conventional primary/secondary/tertiary pumping arrangement. The tank had a set of low head pumps that pumped water to the tank and into the suction side of the original secondary pumps. The tank pumps did not have head capacity to pump into the distribution loop.

This plant suffered from several problems. The major problems were the constant volume tertiary bridges, and the inability to fully utilize the tank. The system did not return the proper chilled water temperature due to the combination of three-way valves, blending circuits, and the varying tank temperatures. The tank itself did not have the ability to vary flow into or out of it, so it caused a false load when charging, and did not add the proper load when discharging.

The system was retrofitted in the winter of 1998 to clean up the hydraulic problems and to remove old CFC machines. New efficient electric chillers replaced the old machines, and a 1000 ton absorption machine was added to decrease the reliance on the local electric utility.

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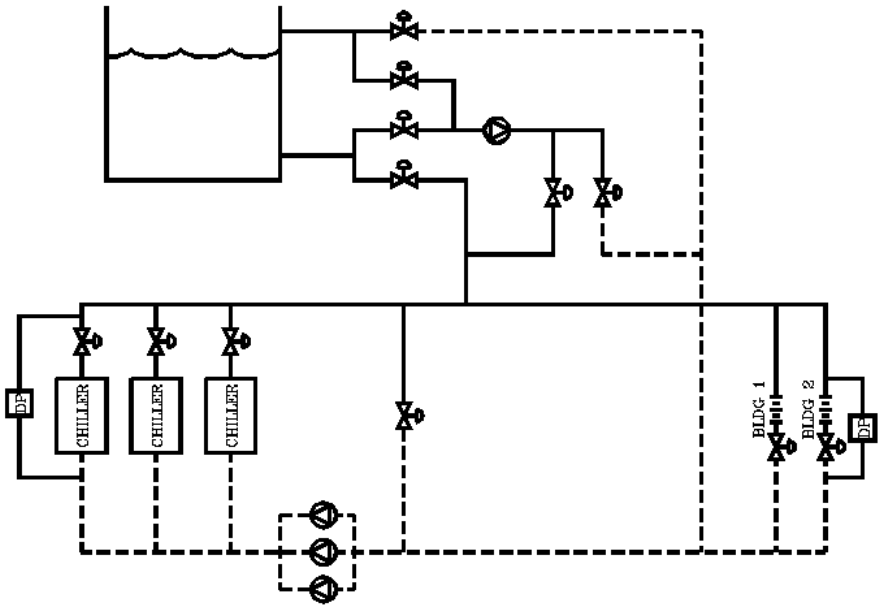


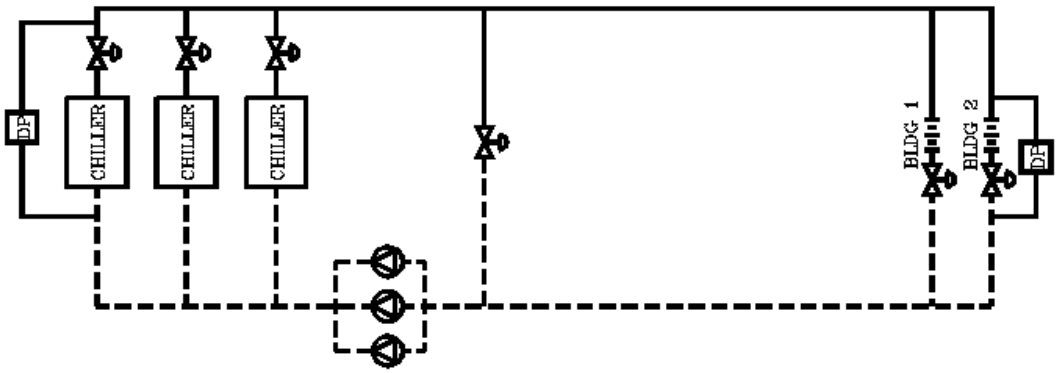
The new chiller plant distribution system is a Systecon VariPrime chilled water pumping system, and the tank system is a standard Systecon variable speed pumping system. The VariPrime system allows for variable flow through the evaporators to account for the different return temperatures coming from the buildings and the tank. The tank pumps are sized to pump the entire system when chilled water is required from the tank.

There are three modes of normal operation for this system. The chillers can be used to serve the load only (Chiller Only Mode), the chillers can be used to serve the load and charge the tank (Tank Charge Mode), and the tank can be used with the chillers to serve the load (Tank Discharge Mode). In an emergency power situation, the tank can be used by itself, but this mode is not part of the normal sequence.

The operational concept behind this plant is to load and run the 1000 ton absorption machine as much as possible. With the large loads on the system, there is generally a 1000 ton load or more on the plant at all times. With this in mind, the absorption machine is always on as long as the plant is operational.

The electric machines are used in two capacities, to either charge the tank or help service the load. Usually during the hours between 6:00 P.M. and 6:00 A.M. an electric machine is operated, with any excess capacity going to the tank. During the hours of 6:00 A.M. to 6:00 P.M., the electric machine is used to supplement the absorption machine to satisfy the load. From 2:00 P.M. to 6:00 P.M., the tank is also used to satisfy the load.

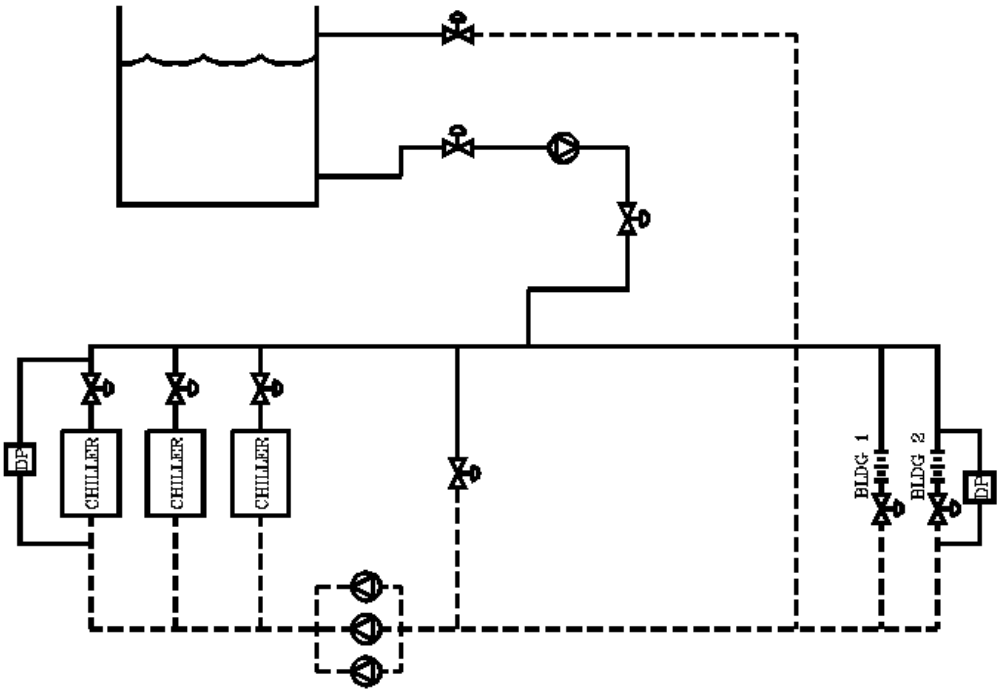
Chiller Only Mode



The plant is operated with the chillers only during the morning hours to satisfy the load. The absorption machine is always on, and is run until fully loaded. The VariPrime pumping system is operated to supply water to the inlet of the eight buildings. As the buildings require more water for increases in the load, the pumps sense a drop in pressure at the end of the loop, and pump more water through the chillers and out to the system. Since the buildings have a combination of different types of loads, the VariPrime system allows the chillers to be fully loaded by varying the water flow to match the different return temperatures coming from the system. Once a machine is completely loaded, a second machine is brought on.

Depending on the time of the year, the Plant Manager has the ability to bring the tank on in lieu of or in addition to the electric chillers. The tank has about 10,000 ton-hours of storage. Usually during the light load months, the tank is brought on in lieu of an electric chiller. In the summer months, the tank is brought on after the first electric machine is brought on.

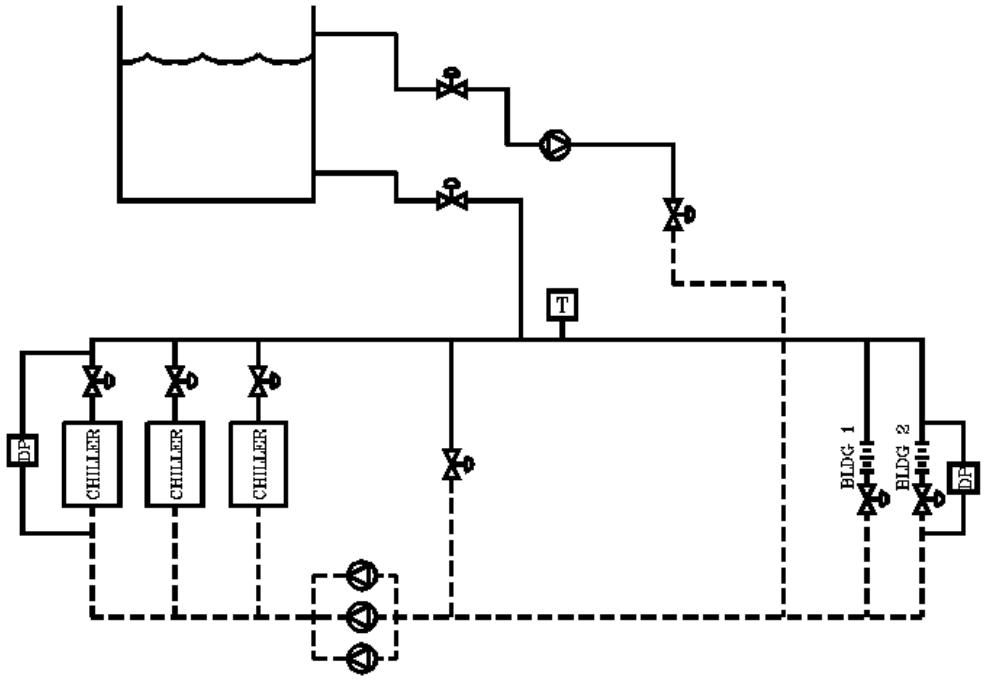
Tank Discharge Mode



When the tank is brought on line, the appropriate control valves are position to allow the tank pumps to deliver chilled water into the supply line, and have the building return water be dumped into the top of the tank. During this mode of operation, the operating chiller(s) are run at rated design flow. The tank pumps are operated to provide enough chilled water required by the system which cannot be produced through the chillers.

To accomplish this, the tank pumps read the differential pressure transmitter at the end of the loop, and speed up or slow down to maintain the loop pressure, similar to the VariPrime pumps normal operation. The VariPrime pumps change speed to maintain a constant flow rate through the chillers, but vary the total dynamic head to keep up with the tank pumps. In this manner, the two control systems work together to always maintain the loop pressure. As more water is needed from the tank, the tank pumps speed up. This increase in flow and pressure causes the VariPrime system to speed up also to maintain the constant flow but increased head pressure. The systems equalize pressure very quickly with the high speed controls installed. Once the system determines that the chillers can maintain the system load by themselves, the tank pumps are turned off. This control allows the chillers to be fully loaded, and provides an easy way for the tank to provide the additional chilled water needed the operating chillers cannot supply to the load.

Tank Charge Mode



During the evening hours, once the load in the system begins to back off, the excess chilled water available is sent to the tank. The tank valves are positioned to allow the chilled water to go into the bottom of the tank, and the warm tank water to be drawn from the top of the tank.

During this mode, the building loop is always satisfied first. The VariPrime pumps monitor the differential pressure transmitter at the end of the loop and vary speed to maintain this pressure. The main valve going to the tank in this mode is modulating. It modulates to maintain a constant supply temperature at T to the loop. The valve will allow a gradual flow of chilled water to the tank until the supply water goes above 42°. At this point, the valve modulates to always maintain the loop at 42°. This simple method allows the amount of flow to vary depending on what is going to the loop, and always keeps the chillers loaded. Attempting to do this with flow meters and constantly changing setpoints originally proved fruitless. Once the valve to the tank has been closed for an amount of time, the operator has the choice to bring on another chiller to continue charging the tank, or to stop the charge mode. On most days, the tank is slowly charged during the evening, and is available for use in the morning.

Conclusion

The overall operation of the plant using the three modes has proven extremely efficient and beneficial to the owner. On all days, the absorption machine runs continuously at or near full load. During the summer months, one of the electric machines runs with the absorber. During the different cycles, the tank is either charged or depleted depending on the loading of the operating chillers.

The plant has seen a great decrease in overall operating costs, especially with the demand charges. The plant for the most part runs at an even KW, since chillers are never cycled on or off, and are essentially at or near full load. Only a slight increase occurs during operation of the tank pumps. However, compared to years past when three or four chillers had to operate, along with associated condenser pumps and towers fans, the system renovations have been a great success. The following chart shows the savings for the first six months of operation since the conversion, compared to the previous year:

Monthly Period	Service kWhrs	Demand kW	Off-Peak General Service – kWhrs	Off-Peak General Service – kW
3/18/98	225600	1340.2	153300	1203.4
4/16/98	408000	1683.6	598956	2192.6
5/15/98	868800	2373.1	265611	1978.6
6/16/98	1188000	2537.5	801978	2218.6
7/16/98	1140000	2181.6	788738	2275.2
TOTAL	3830400	10116.0	2608583	9868.4
3/18/99	112800	1097.8	59314	912.0
4/19/99	182400	1392.0	75195	806.4
5/18/99	506400	1213.2	85034	1177.0
6/17/99	619200	1679.5	425695	1655.3
7/19/99	753600	1788.5	407179	1782.2
TOTAL	2174400	7171.0	1252417	6332.9
DIFF.	*1656000*	*2945.0*	*1356166*	*3535.5*

Cost Savings

Demand charge =	2945 x $13.49 =	$ 39,728.05
Peak Energy charge =	1,656,000 x $.04450 =	$ 73,692.00
Off-peak Energy charge=	1,356,166 x $0.01950 =	$ 26,445.24
		$139,865.29