Luxury Mixed Use Hotel

Southeast U.S.

Thesis – Assignment 1

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Executive Summary

The Luxury Mixed Use Hotel in the Southeast U.S. has many unique spaces that require different HVAC systems. There is a central plant that serves the building with a chilled water system. The chilled water leaving the evaporator part of the chiller serves air handling units and fan coil units throughout the building. There is a pressure de-couple heat exchanger to separate the chilled water system in the tower from the system in the podium levels. Hot condenser water leaves the condenser and is sent to one of two cooling towers with pumps. The water may be bypassed from the cooling tower if it is too cold. There is also domestic hot water pre-heat before the cooling tower.

Since the building is located in the south, it is mostly in cooling season throughout the year. There is electric reheat in most of the units and hot gas reheat in the DX units within the DOAS units. Electric powers the HVAC applications in the building, but there is gas for food service equipment and heating the domestic and pool water.

Public spaces are mostly served by air handling units other than some smaller back of house spaces served by fan coil units. Guestrooms are served by fan coil units and dedicated outdoor air systems (DOAS). The air handling units serving the ballrooms are different than the other typical units because they have a desiccant wheel for high latent loads. The dedicated outdoor air systems have DX units with hot gas reheat from the compressor thermal load. Other than those differences, the air handling units are very similar with fans, filters, coils, and access sections. The fan coil units have coils, fans, and electric reheat.

Exhaust is needed for public and private bathrooms. There are different exhaust rates for the types of bathrooms and other spaces. Elevator lobbies, the laundry chute room, housekeeping, vending, electric rooms, janitor's closets, break rooms, and dishwashing rooms will also have exhaust. The guestroom exhaust will have vertical distribution through shafts in the corridors as do the supply air ducts. Vertical distribution for air delivery helps save ceiling space for coordination with other disciplines. There are fire and/ or smoke dampers wherever necessary to maintain the fire rating.

A Building Automation System helps monitor space conditions and identify if any changes need to be made to the mechanical equipment. There are different energy saving sequences utilized in the building. There is a condenser side heat reclaim with domestic hot water pre-heat. Also, there is a cold bypass if the water is too cold to enter the cooling tower. Condenser water reset can be implemented to lower the condenser water entering temperature to the chiller. Another way to save energy in the building is with allowable chiller evaporator overflow, which lets maximum flow through the one chiller to avoid having to turn both on.

It is a very large system since it serves such a massive building, but the system can be understood more clearly with the schematic diagrams and control sequences. The report below will go further into detail about the systems with figures to show exactly what the systems are made of.

Systems Overview

This project is a mixed-use hotel with many different programs within the building including 516 guestrooms, kitchen and dining areas, ballrooms, a spa, and fitness center. There is approximately 350,000 square feet of lodging area, 180,000 square feet of public area, and 43,000 square feet of back of house areas. Each different zone has different HVAC requirements based off the applicable codes and standards. This building follows the 5^{th} Edition of the Florida Building Codes, ASHRAE 90.1 (2010), and ASHRAE 62.1 (2010).

Per ASHRAE Fundamentals 2013, the outdoor design conditions are as follows:

Cooling	DB/ MCWB @1% Dry Bulb	92.5 °F
	Mean Coincidence Wet Bulb	76.2 °F
Evaporation	WB/ MCDB @ 0.4% Wet Bulb	79.6 °F
	Mean Coincidence Dry Bulb	87.5 °F
Heating	DB @ 99.6% Dry Bulb	37.8 °F
	Extreme Design Condition DB @ n=50-year low Dry Bulb	15.7 °F
Degree days	Heating	550
	Cooling	3,386

To serve the entire building, there is a central energy plant for the chilled water system located in the West end of the parking garage. Equipment was sized off the estimated peak load of 1200 tons of refrigeration. There are two chillers within the plant that are connected to two evaporative cooling towers in a nearby mechanical yard. Each chiller has a dedicated condenser pump with a bypass in case of failures. The number of condenser pumps and cooling towers that are on depends on the number of chillers that are on. To control the speed of the fan in the towers, there are temperature sensors for the condenser water. In case the water entering the cooling tower water is too cold, there is a bypass valve to send the water back to the chiller. This bypass valve is controlled by a flow meter, as seen in *Figure 1*. There is also a domestic water pre-heat before the cooling towers in case the water needs to be heated more, which is controlled by a temperature sensor and an adjustable frequency drive pump. A plant differential pressure sensor controls the speed of the adjustable frequency drives on the pumps. The setpoint for the plant differential pressure sensor is reset by the remote differential pressure sensor. There are also variable volume secondary pumps to supply the chilled water to the air handling units and fan coil units. A pressure de-couple heat exchanger separates the terminal units in the podium levels from those on the tower levels. For the chilled water loop, the desired ΔT is 12.5°F, and it is 10°F for the condenser side.

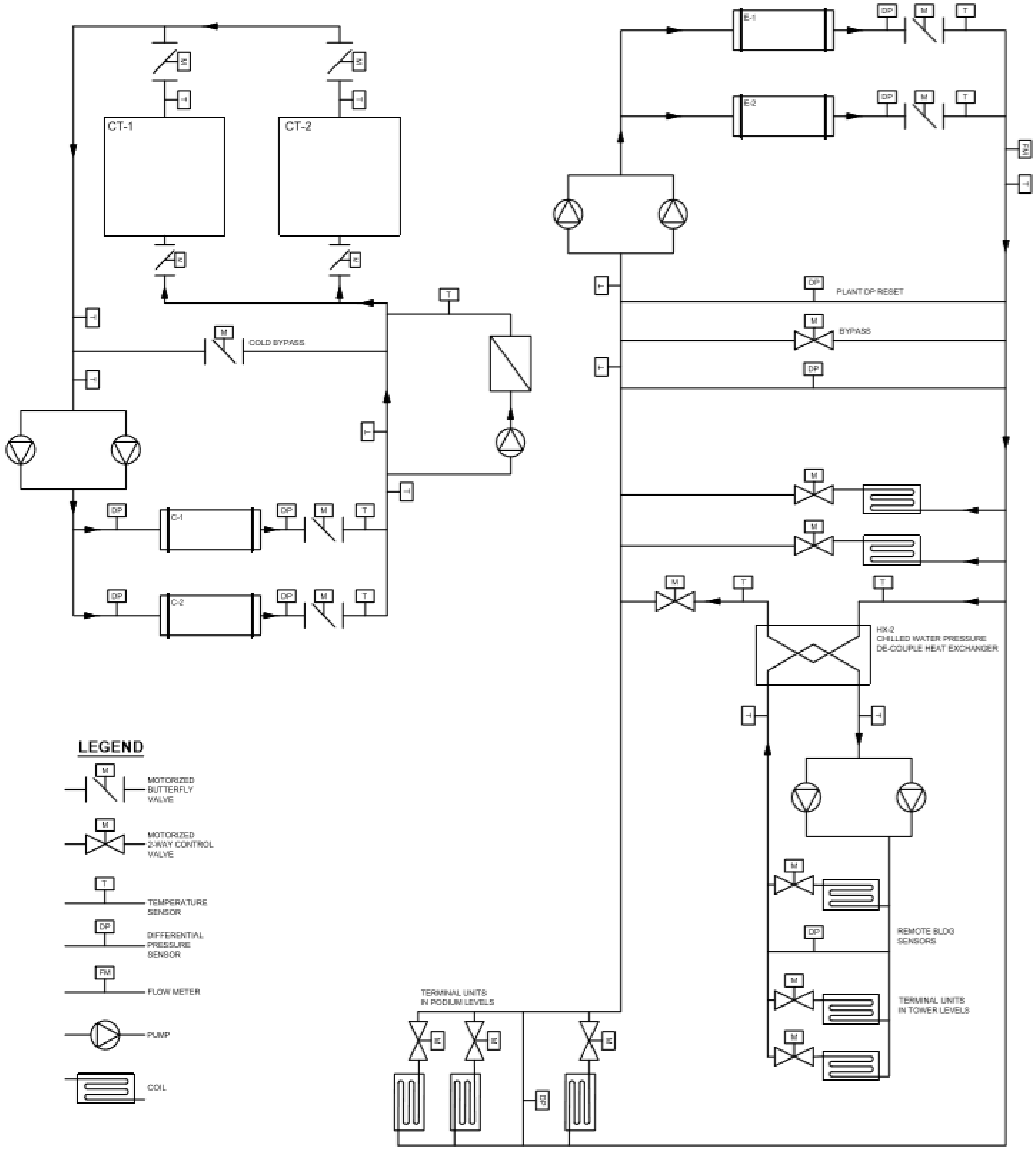


Figure 1: Schematic Diagram of Chilled Water and Condenser Water Systems

The air handling equipment varies depending on the space type. A combination of fan coil units and chilled water and electric heat air handlers serve the public areas. Variable volume air handlers serve the lobbies, restaurants and some other miscellaneous areas; *Figure 2* shows an example of these units. Dedicated constant volume chilled water makeup air units serve the kitchen areas. Guestrooms will have two-pipe fan coil units with electric reheat and will have air supplied by pre-conditioned 100% outside air dedicated outdoor air systems (DOAS).

Air handling units will have 35% efficiency pre-filters and 65% efficiency cartridge type final filters to help ensure proper air quality. Each air handling unit is composed of a mixing box section, a filter section, chilled water cooling coil, an access section, an electric heat section, followed by another access section and a supply fan section. For the ballrooms specifically, the air handling units will have a desiccant wheel to handle the high latent loads as seen in *Figure 3*.

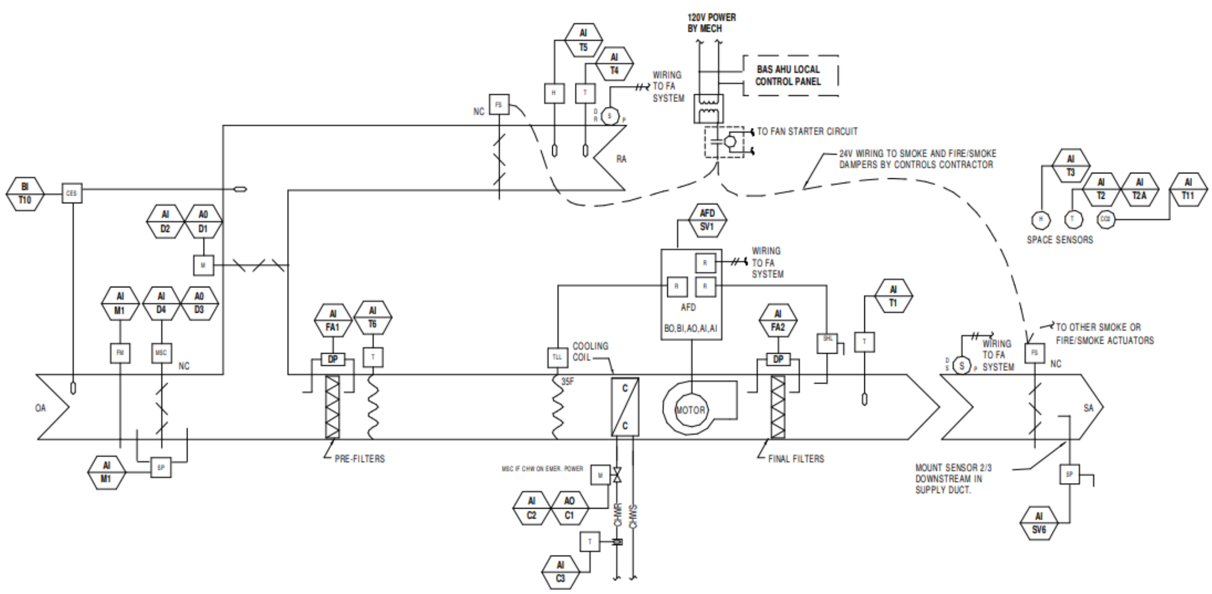


Figure 2: Control Schematic of a VAV Air Handling Unit created by EXP. It shows the fan, filters, different sensors included, and coils.

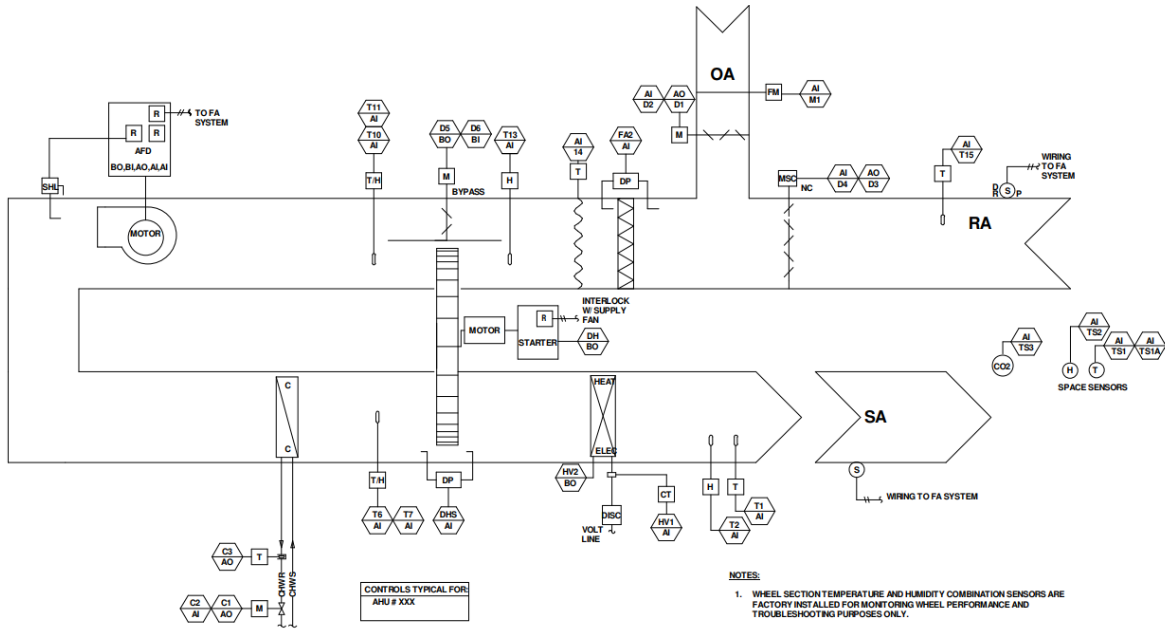


Figure 3: Control Schematic of a Single Zone VAV Air Handling Unit with Desiccant Wheel and Electric Reheat by EXP. It shows the fan, filters, sensors, coils, reheat and desiccant wheel.

DOAS systems serving the guestrooms and corridors are located on the roof of the guestroom tower. They will serve the rooms with vertical distribution down shafts. The DOAS units will be DX units with hot gas reheat. Each one includes a filter section, direct expansion cooling coil, hot gas re-heat coil, access section, electric heat and a variable air volume supply fan section. The hot gas reheat is using heat off the compressors as "free" reheat to make the supply temperature satisfy the desired setpoint in the spaces. A temperature sensor helps modulate the amount of reheat needed from the DX unit. When the temperature is low enough for cooling to switch to heating, there is an electric heat coil in the DOAS unit. *Figure 4* shows the layout of a typical DOAS unit for reference. This figure is a control diagram created by the MEP firm working on this project, EXP.

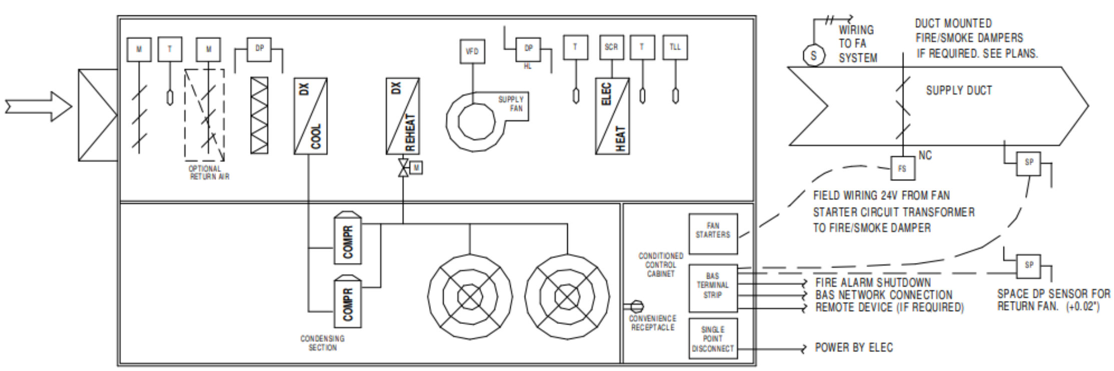


Figure 4: DOAS Control Schematic created by EXP.

There are exhaust risers in the guestroom towers for toilet exhaust. The exhaust will not exceed 50 CFM. To control the exhaust, there will be a 'vacancy switch' so that it can be turned on, but if no motion is sensed in the restroom after a certain time period, it will power off. The ducted exhaust will go to variable speed exhaust fans on the roof. These fans are on the emergency power branch so that they will continue to run if normal power is lost. For kitchen exhaust there will be grease exhaust hoods that are exhausted through up-blast or utility-type fans to the roof. Elevator lobbies, the laundry chute room, housekeeping, vending, electric rooms, janitor's closets, break rooms, and dishwashing rooms will also have exhaust. Public toilet rooms will have exhaust that is at least either 70 CFM or 2.0 CFM/ sq. ft. The garage will also be exhausted based off the minimum ventilation rate of 0.05 CFM/ sq. ft. unless the CO_2 monitors indicate that more exhaust is needed.

Overall, HVAC is powered by electricity. Gas is used for water heaters, pool heaters, and food service equipment. There will be a Direct Digital Control Building Automation System (BAS) to monitor and control the ground floor HVAC systems. Other HVAC systems will be overseen by a centrally located BAS head end system. It will include a computer station for making changes of HVAC equipment and monitoring space conditions. Guestrooms will be controlled separately by digital wall mounted thermostats.

Sequence of Operations

General Air Handling Unit Control Sequence

1. The main supply air temperature setpoint is the controlling temperature for heating and cooling coils in air handling unit (AHU).
2. Control logic shall be provided to prevent unnecessary simultaneous heating and cooling.
3. Provide minimum chilled water cooling coil setpoint value to avoid having a low delta-T problem.
4. Ensure that DX unit has supply air temperature logic to have cooling stages.
5. Provide differential pressure sensors for individual filter sections.
6. Reheat coils to be staged to maintain space temperature at setpoint, which can be changed by the occupant.
7. Supply air temperature is set at 55°F and will have reset logic control.
8. Pre-heat coils will be off during economizer mode, but they will have low limit freeze prevention logic to maintain the coils at least 40°F at all times.
9. Re-heat coil will be off during economizer mode and will be controlled by setpoint temperature when on.
10. Outside Air dampers will open during occupied mode.
11. When space humidity exceeds 60%, dehumidification mode will be enabled until relative humidity drops below 56%. There is a ten-minute delay before the system can begin dehumidification again.
12. Disable fan and shut down unit while in unoccupied mode.
13. Fire alarm will begin shut down of AHU.
14. Freeze-stat will stop fan when it senses temperatures less than 35°F.

15. Provide low-priority alarms for duct static pressure over 0.2”, chilled water under 52°F for over 30 minutes or over 64°F for over 30 minutes.

There are more specific sequences in the appendix from EXP’s Specifications for different types of air handling units.

Waterside Control Sequence

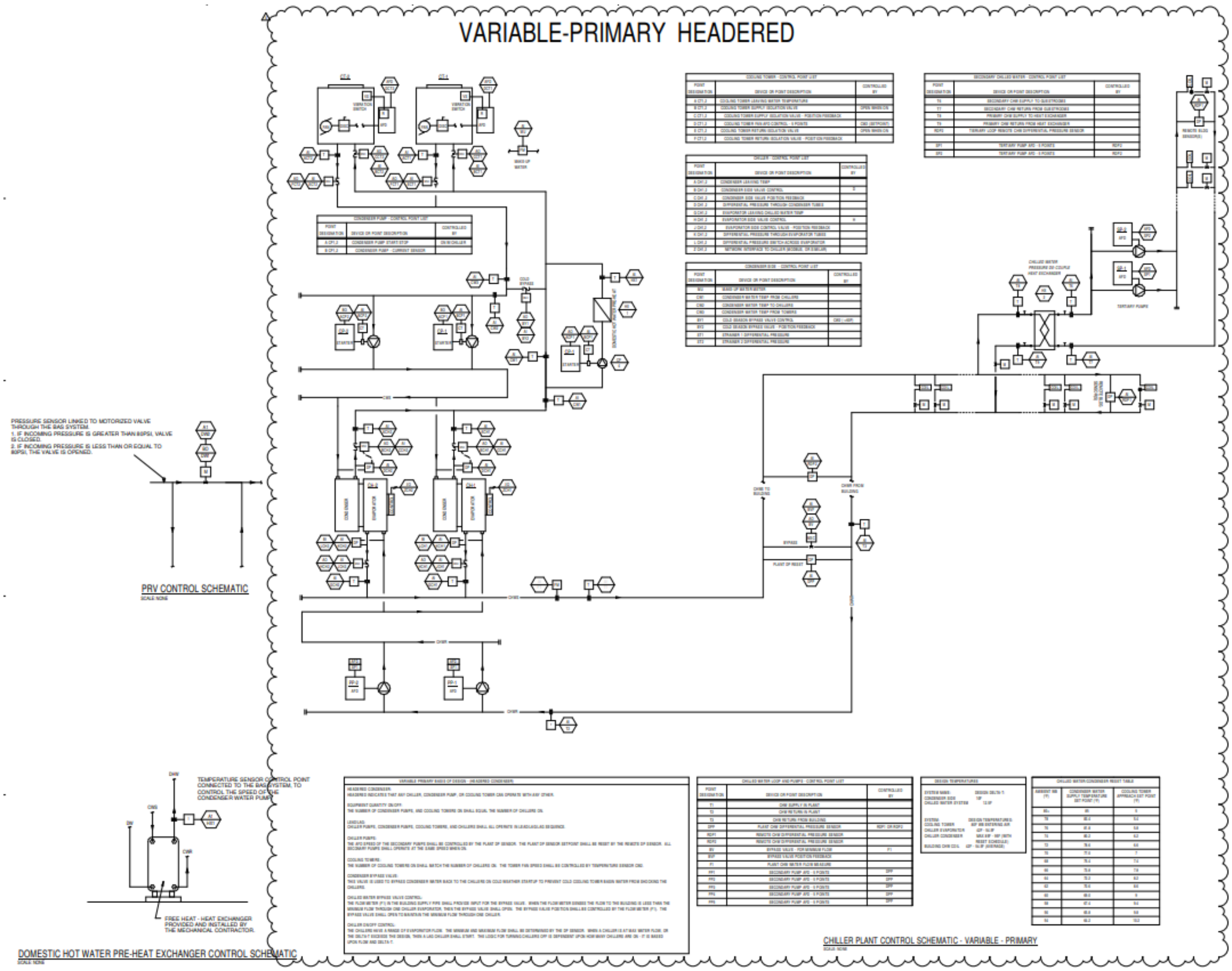
1. Design Intent Temperature Table

Main Chilled Water Loop Supply	42 °F
Main Chilled Water Loop Expected Return	54.5 °F
Main Chilled Water Loop Delta-T	12.5 °F
Normal Mode Chiller Leaving Water	44 °F
Normal Mode Chiller Entering Water	54 °F
Maximum Chilled Water Temp Delta-T	10 °F
Condenser Water Temp Entering Chiller (max)	85 °F
Condenser Water Temp Leaving Chiller (max)	95 °F
Maximum Condenser Water Temp Delta-T	10 °F
Minimum Condenser Water Temp Reset	60 °F

2. Owner will be able to select a time for rotations of lead device. It will be designed for 1 week with the lead device changing on Tuesday at 9:00 AM.
3. The lead equipment will be selected by the piece of equipment with the least cumulative hours of run time.
4. If lead chiller fails operation or has a fault alarm, the lag chiller will be turned on.
5. If lead cooling tower fails operation or has a fault alarm, the lag cooling tower will be turned on.
6. An alarm will be provided for when lead equipment fails. The equipment then gets turned off and removed from the lead/ lag rotation.
7. If BAS network connection is lost, the central plant will be controlled by a dedicated DDC controller or combination of other controllers.
8. When chilled water pumps are configured with a common header, the lead/ lag sequence can be independent from the chillers.
9. If water rises one degree above the setpoint for 10 minutes, the lag chiller will be turned on.
10. The chiller must be on for a minimum of 30 minutes to prevent short-cycling.
11. Turn off lag chiller based off “Subtract Delta-T” values to make sure the capacity is met.
12. Cooling tower operation starts simultaneously with condenser water pump operation.
13. The cooling town fan on variable frequency drive can be ramped down to a minimum of 30% speed.
14. Cooling tower bypass modulated by PID logic.
15. Chiller evaporator overflow will be allowed when the de-coupler temperature sensor exceeds the secondary chilled water setpoint by 2°F. When the second chiller is turned on, the Overflow Mode can be disabled.

16. Condenser water reset can lower condenser water temperature to lower power usage in the chiller when the outdoor dewpoint is below 55°F. If none of the cooling coils are at full cooling, the chilled water setpoint temperature can be reset up 1 degree. When an air handling unit needs full cooling for over five minutes, the chilled water temperature setpoint will return to the what it was before reset.
17. The domestic hot water pre-heat can be used for condenser side heat reclaim.

Appendix



Control Schematic Diagram from EXP.