PREDICTING AND MEASURING BUILDING ENERGY USE COURSE SUMMARY AND FINDINGS
FINAL PRESENTATION

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May 31, 2011
Main Chilled Water Loops

- System or Component Description:
  - Main chilled water loop is connected to the central plant.
  - Chilled water is supplied into the building at about 45°F and exits the building between 55°F and 60°F after gaining heat through the cooling of the building’s equipment and air.

- ID Numbers:
  - Utility Return Water Temperature Sensor – ID#1103
  - Utility Supply Water Temperature Sensor – ID#1104
  - Water Flow – ID#1143
  - Mixed Water Temperature Sensor – ID#1144

- Point Source: Four sensors are used for monitoring and measurement of the main chilled water loop.
MAIN CHILLED WATER LOOP SYSTEM DIAGRAM

Main chilled water loop

Utility Return Water Temp (1103)  
Back to utility

Return Pressure (231)

From components

Diff Pressure (1142)

Valve Position (232)

For maintenance only

Water Flow (1143)

Utility Supply Water Temp (1104)

Mixed Water Temp (1144)

Pump Speed (130)

From utility
2011 Chilled Water Consumption (tons), Chilled Water Flow Rate (GPM), and Outside Air Temperature (°F)

• Function: As the chilled water flow rate increases or decreases, chilled water consumption also increases or decreases. This also correlates with the outside air temperature.

• Performance: Green since performs as expected. Correlation between chilled water consumption, chilled water flow rate and outside air temperature.

• Modes: There appears to be an occupied mode between 04:00 to 22:00.

• There is a trend that follows the outside air temperature.
**2009 and 2011 Main Chilled Water Return and Supply Temperatures**

Yellow Light: Although the temperatures appear to be operating within the expected range, there are missing data.

#1, #2, #3, #4 shows the trendlines for the chilled water supply and return temperatures.

The ReturnTemp did not change from 2009 to 2011.

However, the SupplyTemp appears to have changed from 45°F in 2009 to 43.5°F in 2010. Since the chilled water supply comes from the main chiller plant, inquiring with the Building/Facilities Management would be necessary for reason.

#5 shows a spike in the SupplyTemp. The spike is also reflected in the ReturnTemp as expected. The spikes in are probably due to an increased demand from other buildings or some other activity made at the chiller plant.

#6 Missing Data: Periods where there is missing data.

Recommendation: For missing data, a program could be created to evaluate all the data point for the missing data and generate a report.
Tempered Chilled Water Loops

System or Component Description:
- Tempered chilled water loop feeds water directly into the active beams of Y2E2.
- Water temperature in these systems is around 50°F.

ID Numbers:
- Return Water Temperature Sensor – ID#2400002
- Supply Water Temperature Sensor – ID#2400001
- Supply Temperature Setpoint – ID#1195
- Differential Pressure Sensor – ID#8740009
- Differential Pressure Setpoint – ID#1203

Point Source: Sensors are used for monitoring and measurement of the tempered chilled water loop
Tempered Chilled Water Loop System Diagram
2011 TEMPERED CHILLED WATER

- Supply Setpoint: 55°F
- Function: Maintain temperate chilled supply water temperature setpoint by opening and closing control valve
  - Green Band: Within 5% of setpoint
- Performance: Green since performs as expected. Valve opens and closes to maintain setpoint temp.
- Mode: Occupied.
- At #1, as SupplyTemp increase above setpoint (55°F), valve opening increases until #2.
- At #3, valve closing as SupplyTemp decreases and SupplyTemp is above setpoint.
Yellow Light: Further investigation needed to determine if a problem actually exists.

#1 shows the occupied mode of 2009 ReturnTemp from 06:00 to 19:00.

#2 shows occupied mode for 2011 ReturnTemp from 04:00 to 22:00.

Occupied hours increased from 2009 to 2011. Was this intentional? Possible savings if revert back to 2009 occupied hours.

#3 Missing data: Large portion of January 2009 and other periods where the color of carpet plot is white in 2009 and 2011.

#4 We see occupied hours shift due to daylight savings.

#5 We also see a shift back to schedule prior to daylight savings near beginning of April. Possibly due to a seasonal shift in schedules?

Recommendation: Investigate the reason for increasing the occupied schedule and possibly revert back to a more reduced occupied schedule for energy savings. For missing data, a program could be created to evaluate all the data points for the missing data and generate a report.
2009 Heat Recovery Bypass Valve Problem

- Heat recovery bypass valve opens and closes rapidly during transitional periods
- Recommendation: Program Heat Recovery Bypass Damper to include a time delay of at least 2 minutes

Recommendations for Owners

![Graph showing heat recovery bypass damper position on April 2.](image)

Vertical lines are damper opening and closing. Outside temp > 65°F => damper closed?

Closer look: Something funny.

Conclusion: Outside air temp is a driver, but probably not this particular sensor. The damper position is probably informed by another sensor. Either way, this is inefficient. ✗
FUNCTION OF HEAT RECOVERY BYPASS VALVE

- From Week 3 Lecture, Y2E2 – HVAC sequence of operation (controls)
  - Heating
    - If
      - outside air temperature < heat recovery leaving temperature &
      - exhaust air temperature > heat recovery leaving temperature
    - Then - heat recovery bypass damper closed (heat recovery “on”) otherwise open
    - Heat recovery bypass damper modulates to set supply air temperature to setpoint (65°F)
  - Cooling
    - If outside air temperature > exhaust air temperature
    - Then - heat recovery bypass damper closed (heat recovery “on”) otherwise open
    - Heat recovery bypass damper modulates to set supply air temperature to setpoint (65°F)
2009 Heat Recovery Bypass Valve Problem

- Red light because of the problem of the valve rapidly opening and closing.
- According to the function for the heat recovery bypass valve from previous slide, valve does not function correctly.
- For heating: Valve=0% when, Exhaust Temp > Heat recovery leaving temp > Outside Temp
2009 Heat Recovery Bypass Valve Problem

- Red light because of rapid cycling of valve.
- Problem of heat recovery bypass valve rapidly opening and closing at transition.
- Band of heat recovery mode should be wider according to the function of the heat recovery bypass valve.
- For heating: Valve=0% when Exhaust Temp > Heat recovery leaving temp > Outside Temp
Yellow light. Original problem corrected, but new problems.

Although the valve no longer have the problem of rapidly opening and closing as in 2009, the valve still does not quite operate according to the function of heat recovery bypass valve.

For heating: Valve=0% when, Exhaust Temp > Heat recovery leaving temp > Outside Temp

For cooling: Valve=0% when, Air temperature > Exhaust Temperature

Fixing the rapid opening and closing on transitions would allow the system be more efficient and reduce wear and tear on the valve.

#1 Outside air temperature increases from 65°F to 68°F and above Exhaust Temp when time scale changes. Which is correct? Bug in See-It? Corrupt data?

#2 When unoccupied on the weekend (5,6 FEB), valve appears to cycle more often. Inefficient and causes unnecessary wear and tear on valve.

Information of the actual control logic of the heat recovery bypass valve and knowing which graph is correct would be needed to fully assess problem.
**Wiki user guide**

- Group’s Wiki is a collection of all research and work performed this quarter.
- Work is summarized with appropriate links to specific areas of research such as systems and their measure data.
- Group made best attempt to make Wiki user friendly.
- Traffic light designations.
- Make work concise and to the point.
GENERAL COMMENTS AND RECOMMENDATIONS - BUILDING

Building Recommendations:

- Investigate the reason for increasing the occupied schedule and possibly revert back to a more reduced occupied schedule to for energy savings. This applies to the tempered chilled water system.

- For missing data, a program could be created to evaluate all the data point for the missing data and generate a report.

- Justify and explain schedule changes in general for systems.

- AHU outside air temperature has different values at different time scale. Possible bug in See-it, or corrupt data when changing time scales. Needs debugging.
GENERAL COMMENTS AND RECOMMENDATIONS – UNIVERSITY (OWNER)

- Apply the recommendations for the building to other similar buildings that the university intends to create.
- Commission and monitor the systems.
- Place and implement sensors in all new buildings to check on behavior of engineering systems.
- Have a method of control in place for the systems to allow for easy adjustment for optimal performance.
- Hire experienced individuals with analytical backgrounds in measured building data to oversee the buildings.
GENERAL COMMENTS AND RECOMMENDATIONS – INDUSTRY, TEACHING, AND RESEARCH

Industry:
- Provide more training for building managers.
- Have an employee on staff that is trained in analyzing building data.

Teaching and Research:
- Improve software tools that can be used in industry for students
- Provide real world experience opportunities for students to gain firsthand experience
- Identify efficient methods for recording and analyzing data to minimize probability of errors.
- Create or provide manual that allows students to better analyze data. The manual would contain information regarding the logic and background behind sensors and systems in building.