Term Project Report

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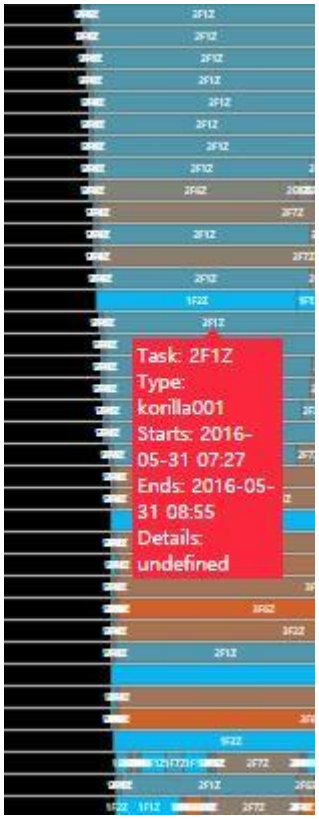
Q1. Five Typical Pattern of employees

You can see the graph on the following link.

https://aldlfkahs.github.io/VAST-challenge-2016-MC2/proxy_card_data_chart.html

You can use the x-axis and y-axis scrollbar to navigate through the graph. If mouse is on the graph, tooltip box shows the information of that time. "Task" means the location of employee (mFnZ means m'th floor n zone), "Type" means the proxy ID of employee, "Starts" and "Ends" means the entering time and exiting time respectively. Each location is distinguished by color.

Pattern 1) Most of employees go to work at 7am to 8am and leave work around 5pm



Except the late shift members, most of employees go to work between 7am to 8am. It can be inferred that commuting time of the company is up to 8am. They leave work around 5pm. They do not go work at weekend.

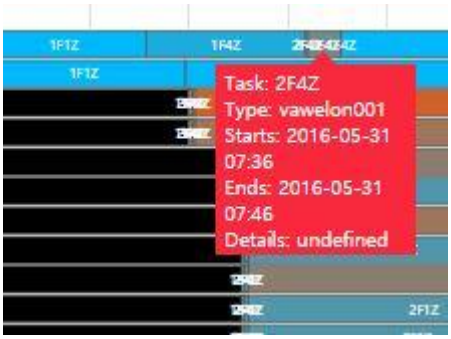
Pattern 2) Most of employees have lunch at 12pm to 1pm

Most of employees pass through 1F1Z at 12pm and 1pm. Because that zone is the entrance of the building, we can guess that they exit the building to have lunch at that time. In addition, we can also infer that company gives an hour for lunch break.

Pattern 3) Late shift workers of IT and Facilities department go to work around 4pm and leave work at midnight

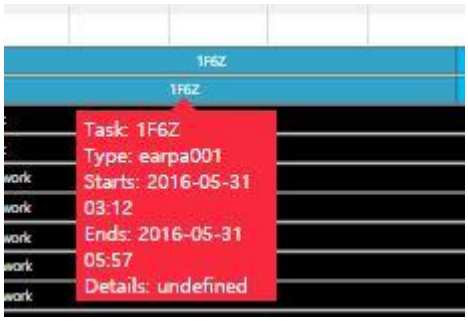
Late shift members go to work around 4pm. Most of them are from IT or Facilities department. Most of the late shift workers leave work at midnight. Based on the preceding patterns, we can figure out that the late shift workers work 8 hours (4pm to midnight), while day shift workers work 9 hours (8pm to 17pm).

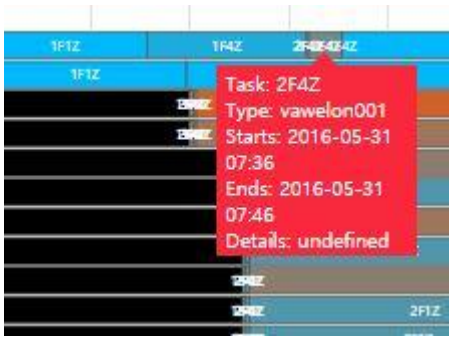
Pattern 4) Two employees from Facilities department work during dawn



Two members of Facilities department work during dawn. They start to work at midnight and leave work at around 7pm. We can infer that the company deploys two workers at dawn.

Pattern 5) Two employees from Facilities department who work during dawn are usually at Deli and one of them always leave work later than the other.





Most of time, they are at 1F6Z. Since 1F6Z means first floor zone 6 (1060), which is Deli, we can figure out that they usually are at Deli. We can also find interesting pattern that one of two workers always leave work later than the other. Since he or she visits many places in short time, it seems that the worker checks the other zones before leaving work.

Q2. Five Interesting Patterns of building data

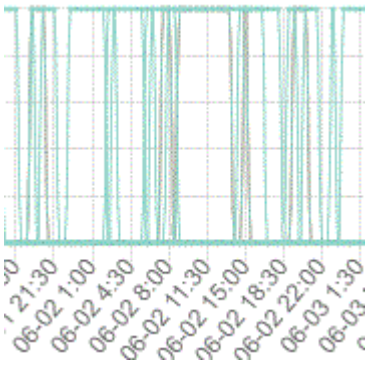
You can see the implementation on the following link.

https://aldlfkahs.github.io/VAST-challenge-2016-MC2/building_line_chart.html#

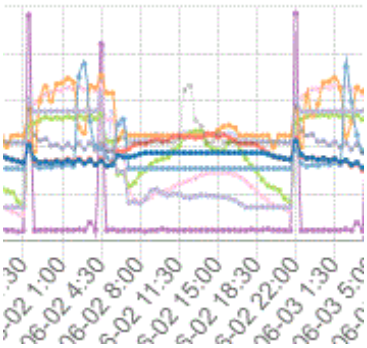
In the main page, you can see the building layout of the company. Graphs are implemented in second tab "Building Data AND Hazium". It may not work at first, so please try to refresh page if you cannot see any graph or only one graph in second tab. The x-axis represents the sequential time, and because all graphs have same interval for x-axis, you can easily compare the values of the same time. The y-axis represents each values of the building data. Pink area represents the weekend. When mouse is on the graph, tooltip box shows the values at that time. If you want to see only specific data, you can remove other data by clicking index under title of each graph.

Pattern 1) Fluctuation during weekday

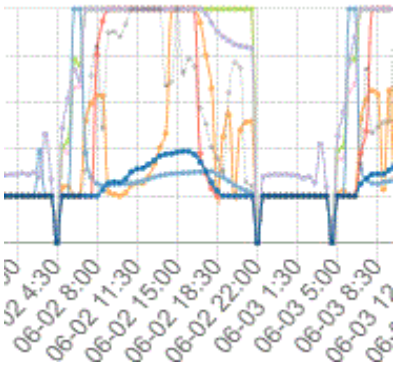
Light&Equipment Power



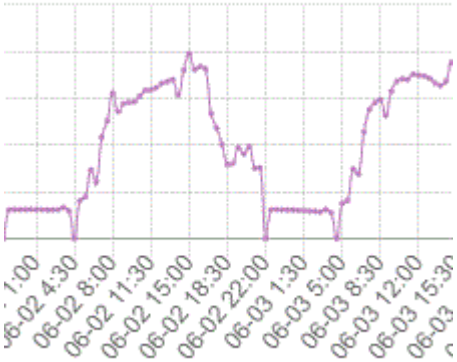
Temperature Data



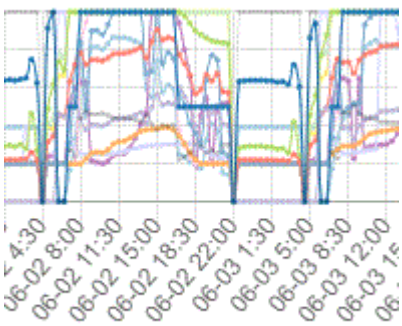
VAV reheat damper position



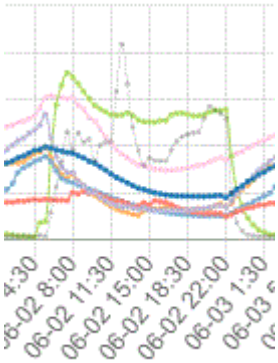
VAV SYS cooling coil power



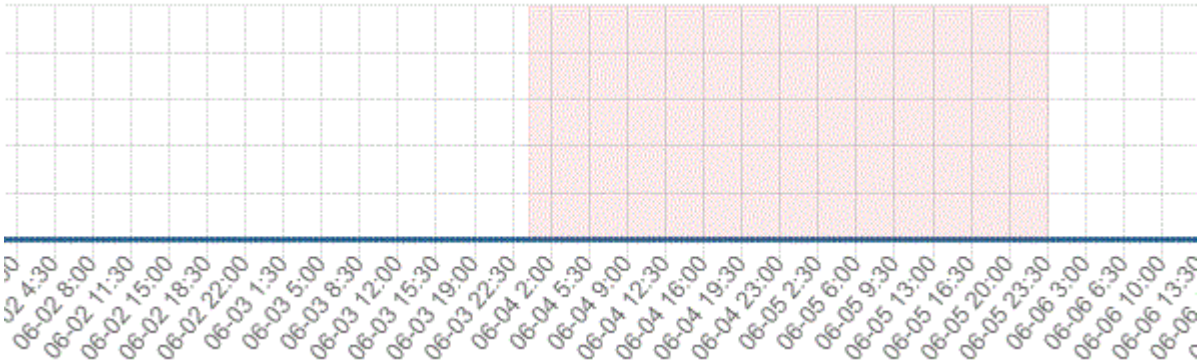
Mass flow rate



CO2 Concentration

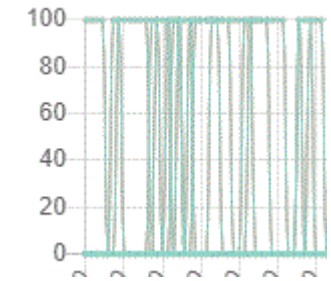


Reheat Coil Power



Light&Equipment Power, Temperature Data, VAV reheat damper position, VAV SYS cooling coil power, Mass flow rate, CO2 Concentration show a lot of fluctuations during weekday. However, the Reheat Coil Power shows 0 power through the period.

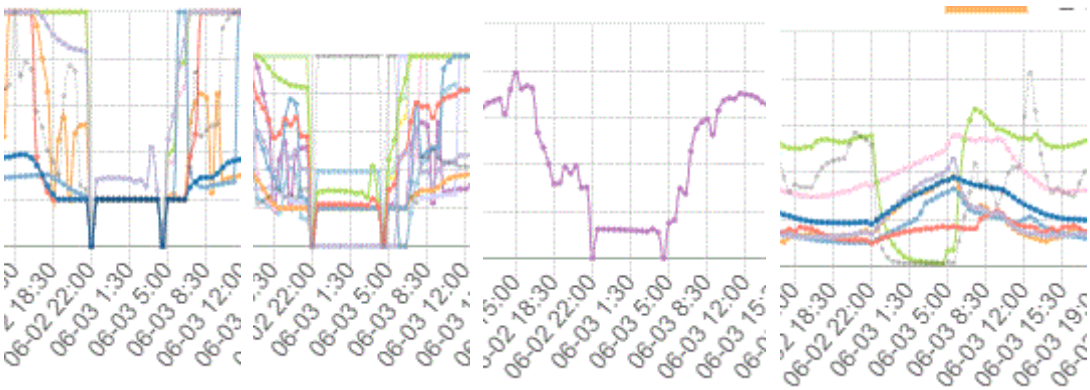
Pattern 2) Only two options in Light & Equipment power



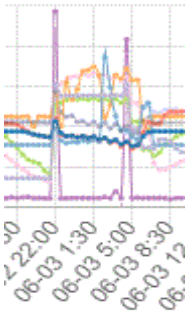
These sensors show only two levels of energy. It records 100% or 0%. This means it has the only two options to turn on and turn off.

Pattern 3) Repeated pattern during weekday

VAV Damper Position Mass Flow VAV SYS cooling Coil CO2 Concentration

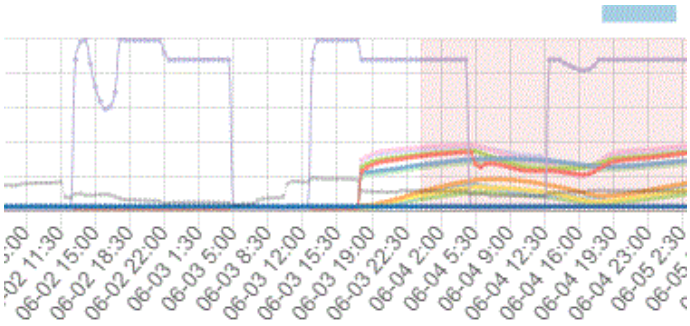


Temperature Data



All of the graph show repeated pattern on every weekday's 06:00~22:00 and 22:00 ~ next 06:00. VAV Reheat Damper Position, Mass Flow Rate, VAV SYS cooling Coil Power, CO2 Concentration go down at night. However, temperature goes up at night, so we can guess that this is the summer period. In addition, the air conditioner is turned off at night.

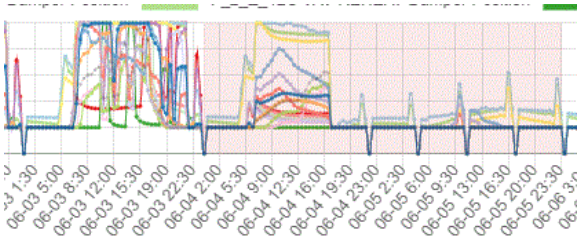
Pattern 4) Stable & Regular temperature



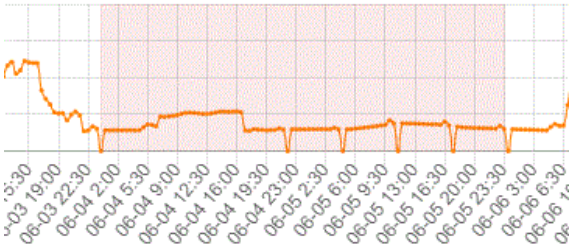
The supply inlet temperature shows quite a stable graph except anomalies pattern. But, the third floor supply inlet temperature shows some value on the weekend. This floor's Supply Inlet Temperature stable and low in weekday, high stable in the weekend without zone1's temperature.

Pattern 5) Peak value at midnight

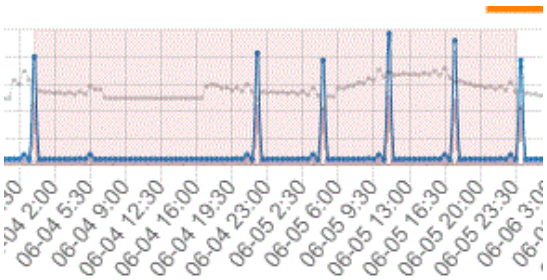
VAV Reheat damper position



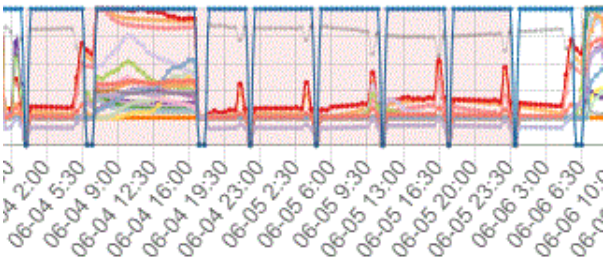
Reheat Coil Power



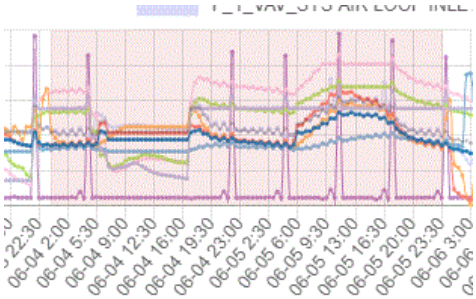
Supply Inlet Temperature



Mass Flow Rate



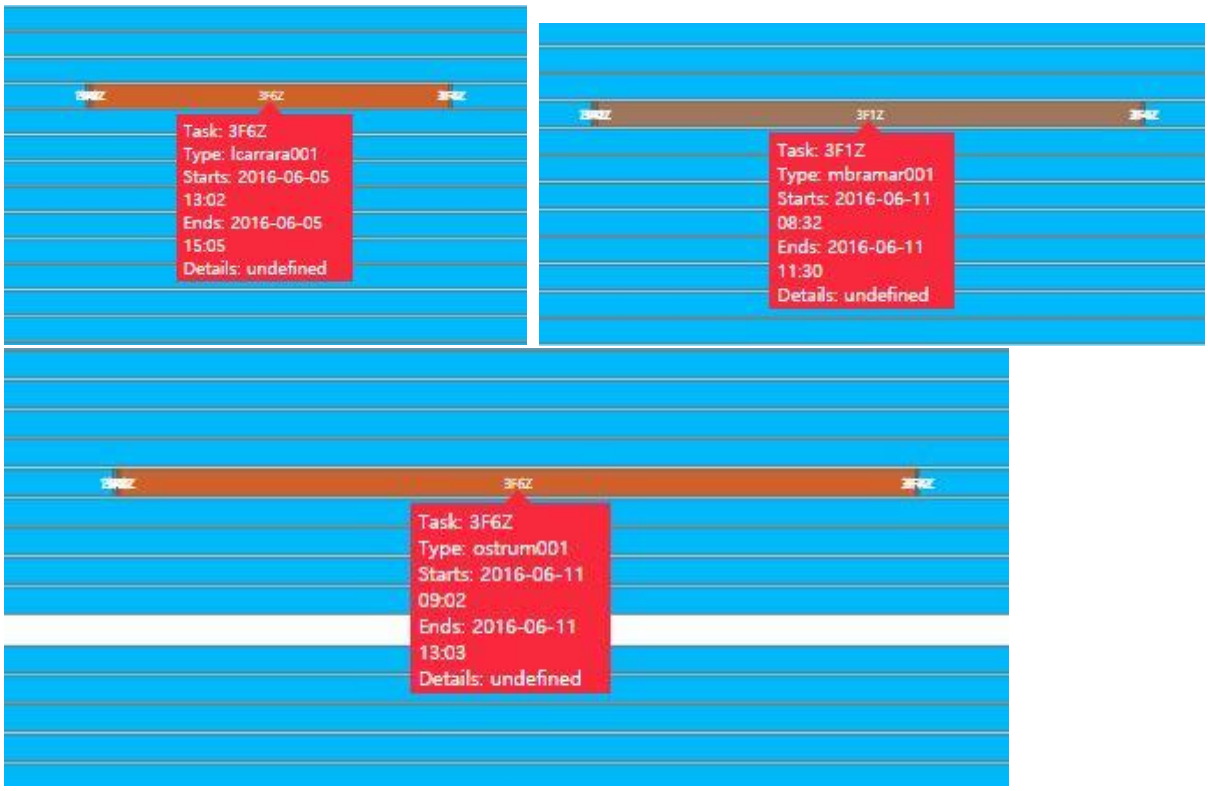
Temperature Data



At the weekday's midnight 00:00 some of the sensors show high peak or low peak. At the weekend those sensors show several high or low peak at Sat 22:00, Sun 4:30, Sun 11:00, Sun 17:30 and Mon 00:00.

Q3. Five Notable Anomalies

Anomaly 1) Some people visit the office during weekend.

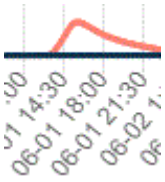


All workers rest in weekend. However, there are three people who visit during weekend. Proxy ID of lcarrara, mbramar and ostrum are them. They are Carrara Lise from Administration department, Bramar Mat from Administration department and Strum Orhan from Executive from Executive department. They stayed more than 2 hours in one place.

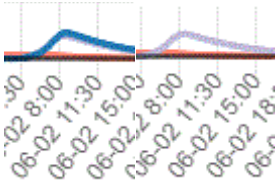
Anomaly 2) Abnormal Hazium

The most important is Hazium level which is the one of the main topics of this project.

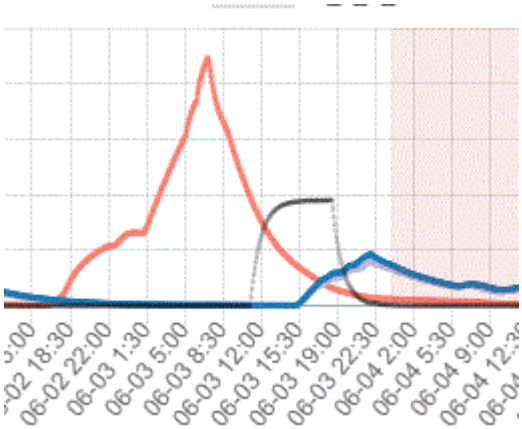
The first peak of hazium which start to increase at 06-01 13:00.



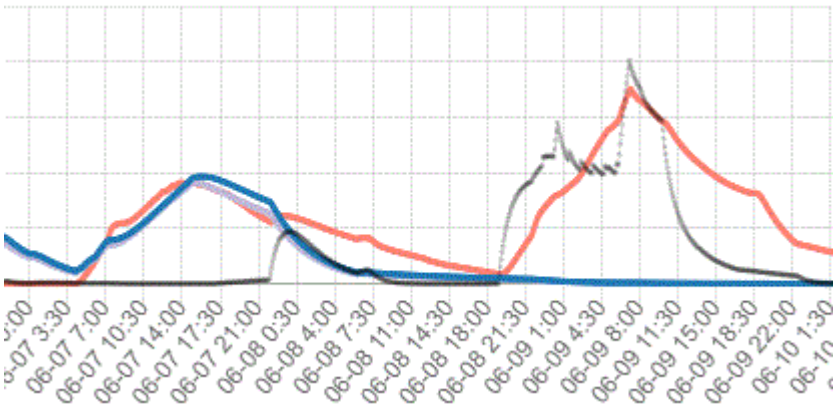
The second peak of hazium starts to increase at 06-02 06:00



Above is the sequential peak of hazium. Also, the purple line and blue line show the same pattern. This sequence starts at 06-02 17:00, 06-03 11:00 and 06-03 15:20.

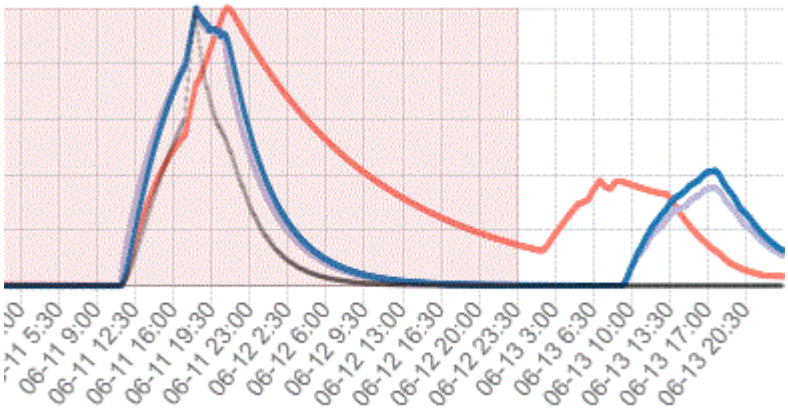


Above graph shows the day of high-temperature peak and after the issue another peak occurred. The start of the issue day the concentration of Hazium was increased. Also, after the issue day, two Hazium sensors show high peaks, which was started at 06-08 19:00.



Finally, the Hazium sensors report the highest peak on the second weekend. It starts at 06-11 11:00, reaches the highest peak at 18:00 and linearly goes down. However, the Hazium level increases

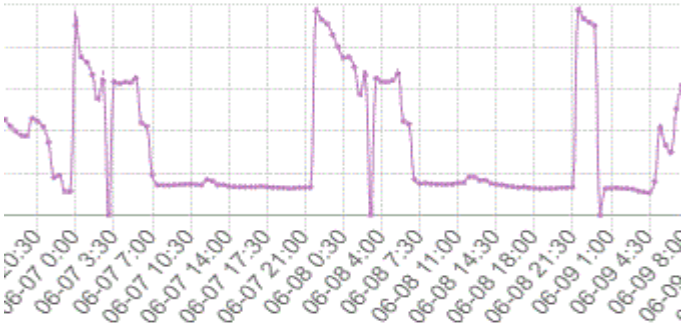
again in floor3 zone1 at 06-13 01:30 and other floors increase again at 9:30.



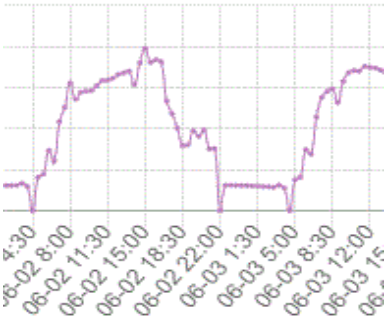
Anomaly 3) Lots of error on Tue 06-07 07:00 ~ 21:00 and Thr 06-08 07:00 ~ 21:00

There are issues with Temperature data, VAV Reheat Damper Position, Coil Power, Mass flow rate, CO2 Concentration, Supply Inlet Temperature. Those malfunctions are observed at the entire building. First of all, the cooling system represents the same level as the ordinary weekday's night.

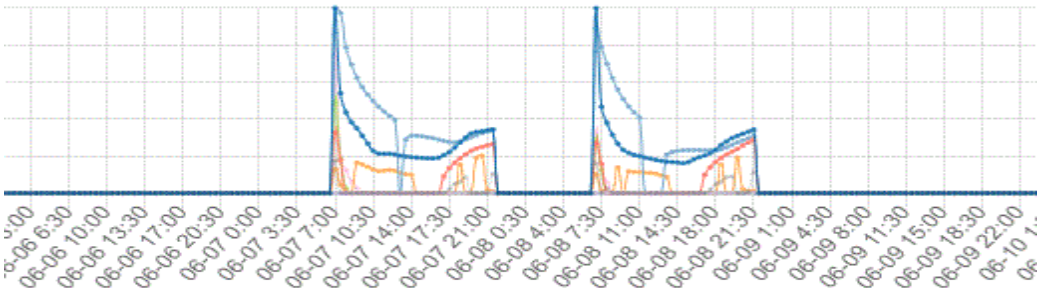
Problem Days



Ordinary Day and Nighttime

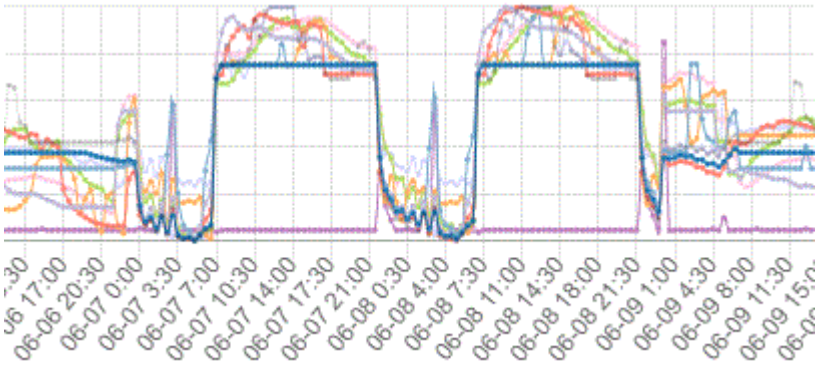


Also, the Reheat Coil power increases.

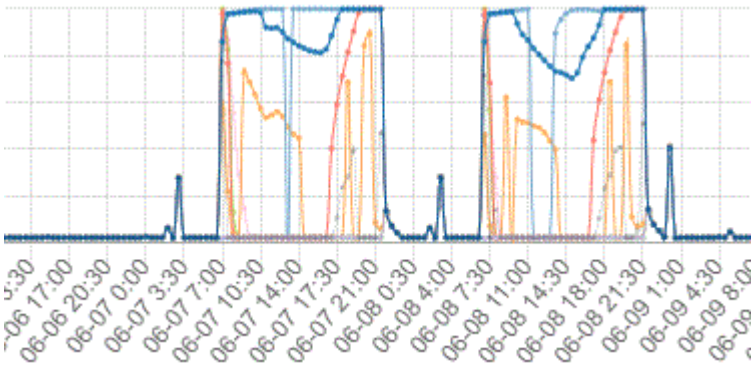


We can assume that it may cause some temperature issues in the building and the air conditioner and heater was flipped as we assume the problem was occurred that days. All temperature data, CO2 Concentration increase, and Damper Position shows low stable.

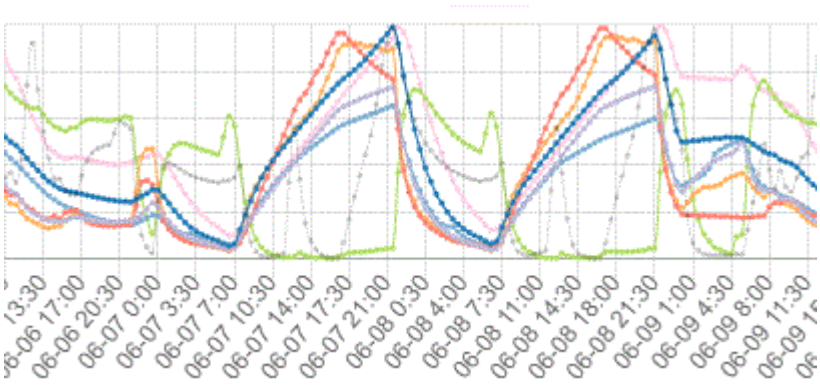
Temperature Data



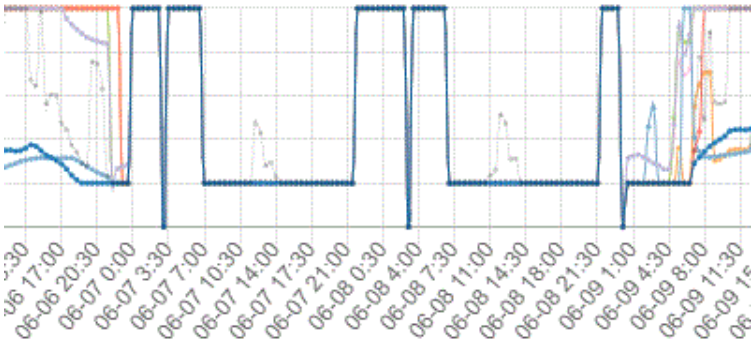
Supply Inlet Temperature



CO2 Concentration



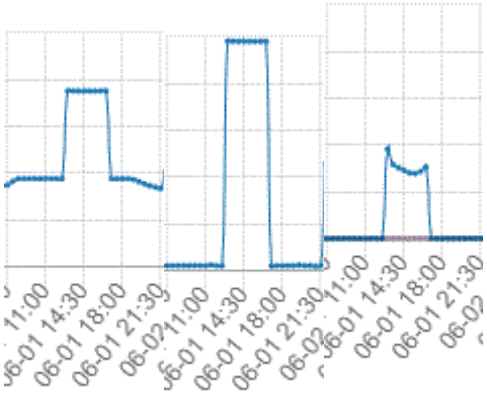
Damper Position Data



Anomaly 4) Wired peak 06-01 afternoon in floor1 and 3

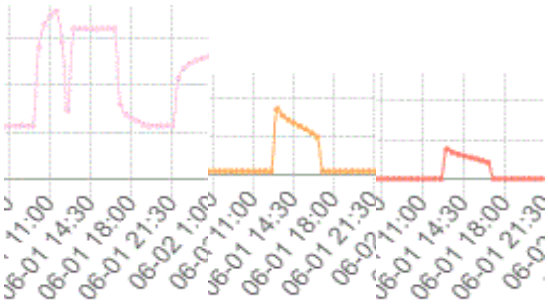
Temp, heat coil, inlet temp record high peak at a certain time. In first-floor zone 2, at 06-01 13:00 to 14:30, there is a high peak of all temperature data and Reheat Coil.

Temperature Reheat Coil

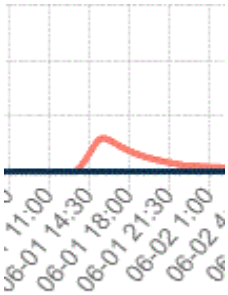


Also, in third-floor zone 5, at 06-01 13:00 to 14:30 there is a high peak of all temperature data and Reheat Coil.

Temperature Reheat Coil



The Hazium Concentration in third-floor zone 1 has a peak at the same time.

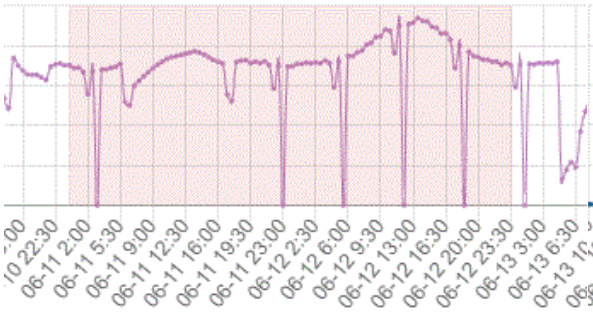


We suspect that it is a preliminary investigation of the case 06-07 and 06-08.

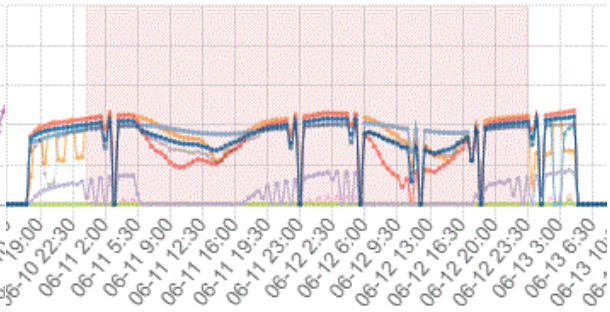
Anomaly 5) Anomalies at the second weekend

There are some anomalies in the second week period. There are anomalies with 1st and 2nd floor's Coil power and inlet Temperature. In ordinary weekends, the Cooling Coil power level is low and the Reheat Coil power level is 0. However, both cooling power and heat power level is very high.

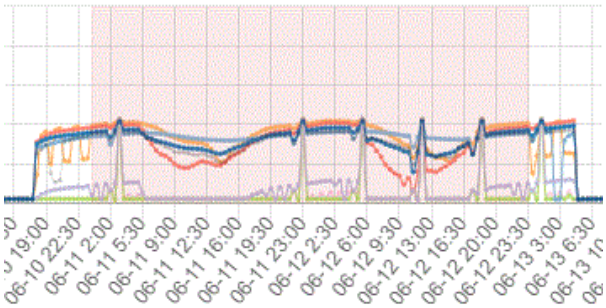
VAV SYS Cooling Power



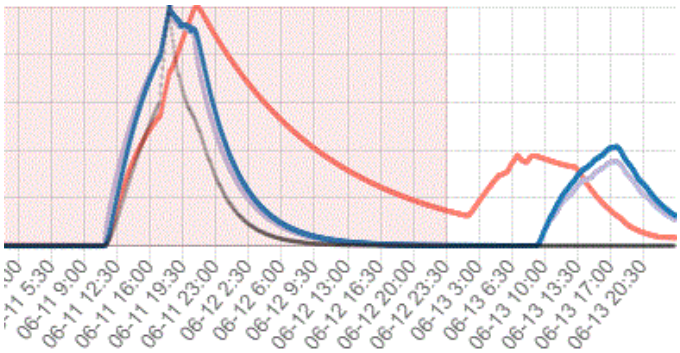
VAV Reheat Coil Power



Also, supply Inlet Temperature level is high. This value maintains almost 0 in an ordinary case.

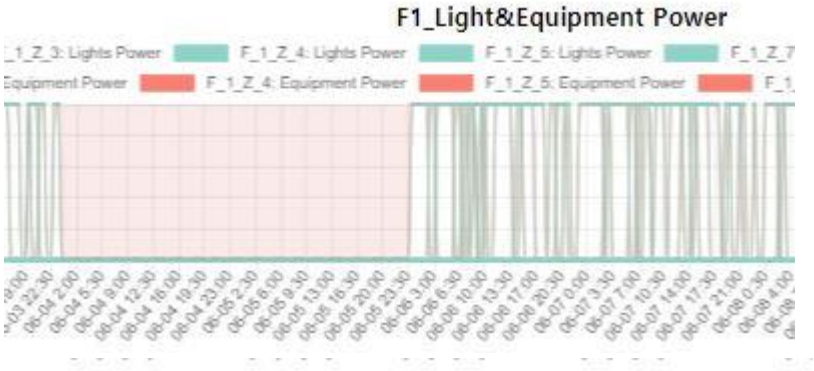


On that day the Hazium concentration sensor was recorded the highest value.



Q4. Three Observed Relationships Between the Proximity Card Data & Building Data

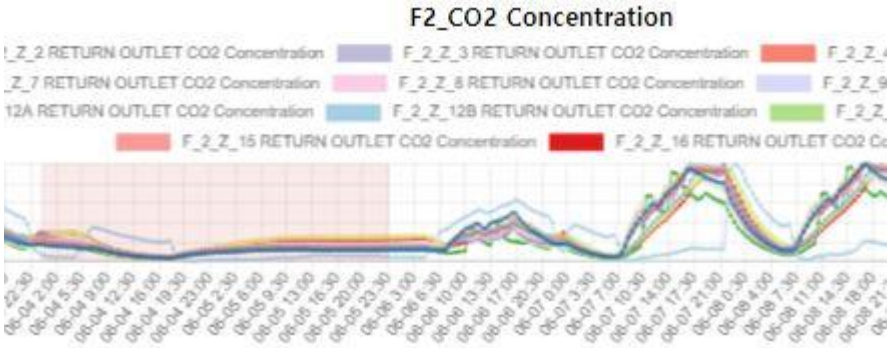
Relationship 1) Power usage dramatically drops during weekend

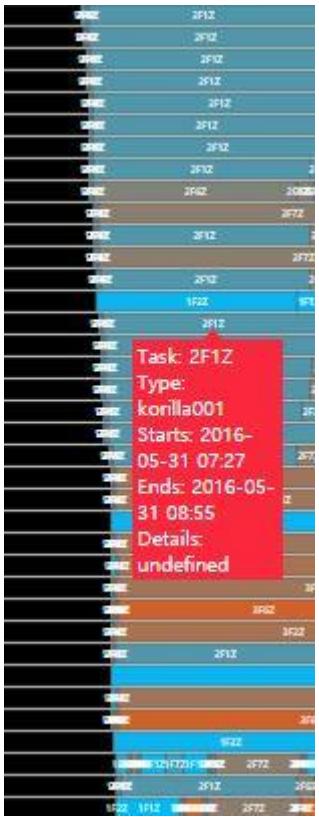


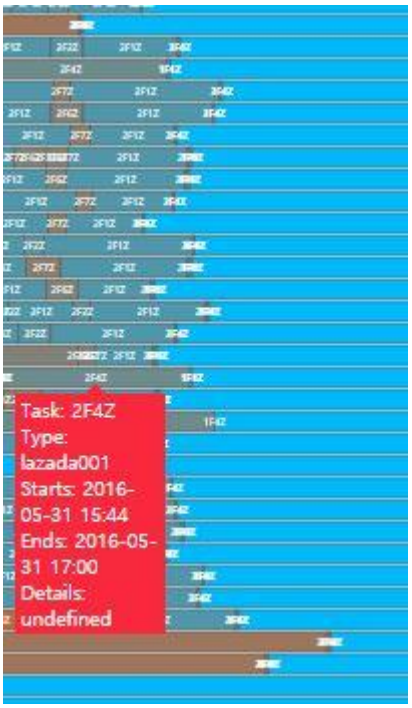
No workers on weekend

Pink area of first two graph represents weekend. Since the employees of the company do not work on weekend, no power is needed at that time. Thus, we can see that there is almost no power on weekend.

Relationship 2) CO2 concentration





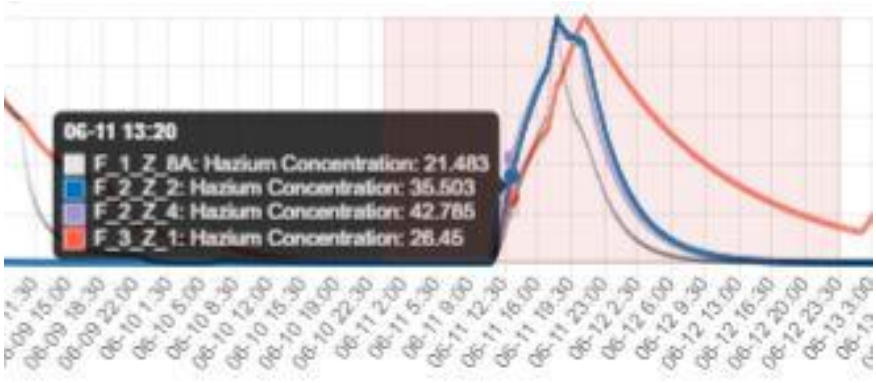


When workers come to the company, the CO2 concentration starts to increase. It's because human emits CO2 during breath. Then, it gradually decreases from the around of quitting time.

Relationship 3) Hazum concentration surge right after leaving of Bramar Mat during weekend

Bramar Mat's visit on weekend

Hazium concentration



Abnormal visit of Bramar Mat was described at Question 3-1. When we compared this information with the building data, we figured out that Hazium concentration increases rapidly right after Bramar Mat left the building. We can infer that Bramar Mat might did something suspicious behavior during the visit.