The Challenge

You have been hired by a Coal Terminal to assess which of their Coal Reclaimer machines require maintenance in the upcoming month.

These machines run literally round the clock 24/7 for 365 days a year. Every minute of downtime equates to **millions of dollars** lost revenue, that is why it is crucial to identify exactly when these machines require maintenance (neither less or more frequently is acceptable).

Currently the Coal Terminal follows the following criterion: a reclaimer-type machine requires maintenance when within the previous month there was at least one 8-hour period when the average idle capacity was over 10%.

Idle Capacity is a utilization metric which, for the purposes of this project, is defined as:

$$\text{Idle Capacity} = \frac{(\text{Actual Tonnage} - \text{Nominal Capacity})}{\text{Nominal Capacity}}$$

Your task is to find out which of the 5 machines have exceeded this level and create a report for the executive stakeholders with your recommendations.
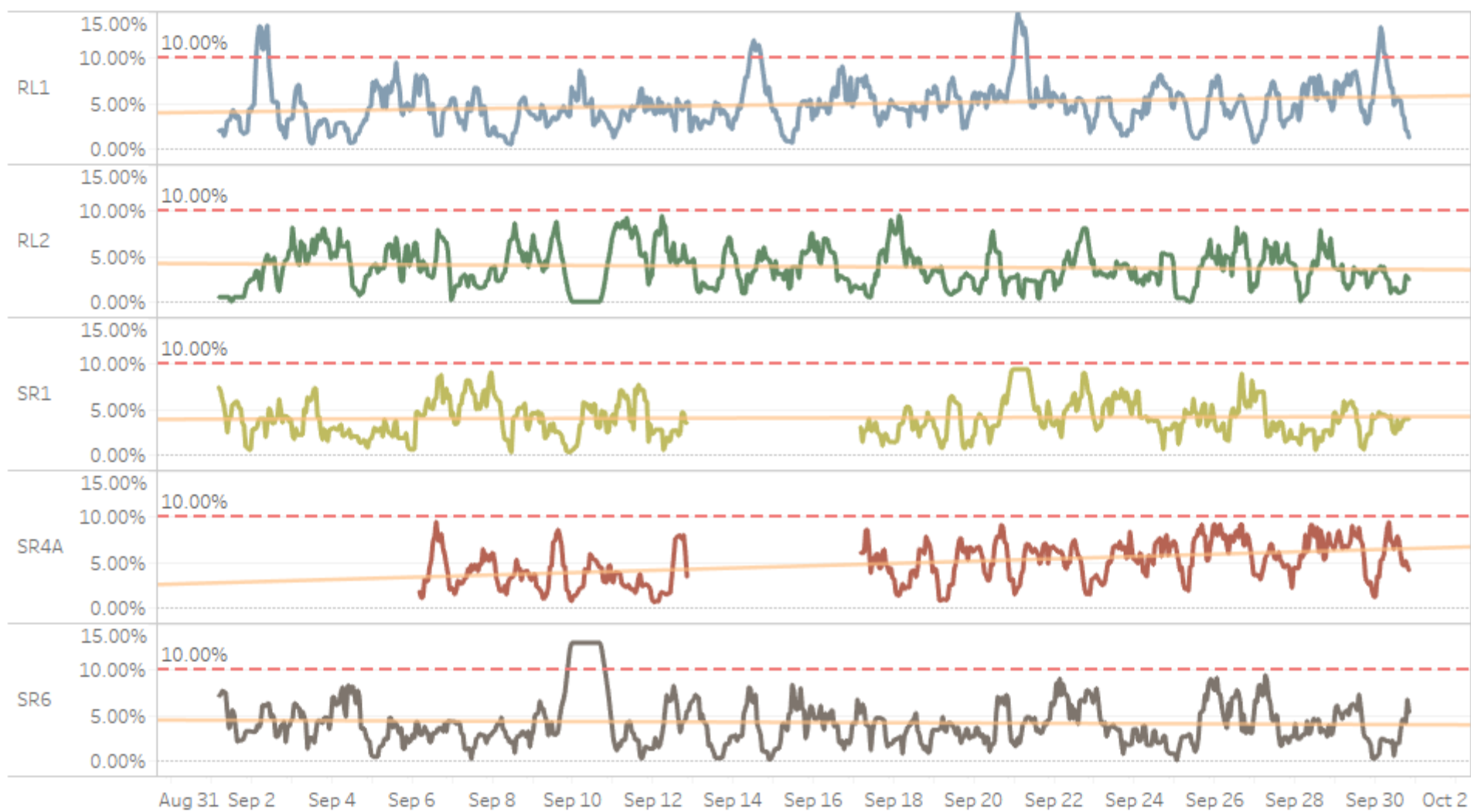
Reclaimers

Reclaimer 1 (RL1)

Above, we see an 8-hour moving average of idle capacity of Reclaimer 1 (RL1) expressed as a percentage of nominal capacity.

Throughout the month RL1 exceeded the allowable threshold four times:
9 Sep - 14% maximum rolling average
14 Sep - 12% maximum rolling average
21 Sep - 15% maximum rolling average
30 Sep - 13% maximum rolling average

In addition, the data is presenting an upward trend of unused capacity for this machine. If this trend continues, every hour of operation will be increasing idle capacity by roughly .05% over time. It is evident that this machine requires maintenance as a top priority.

Reclaimer 2 (RL2)
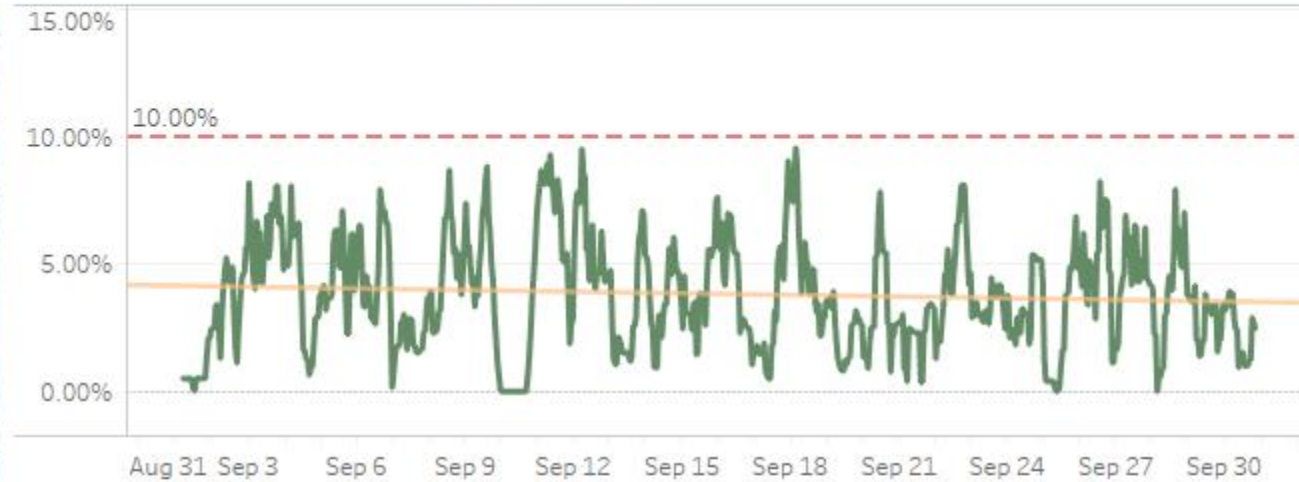
Above, we see an 8-hour moving average of idle capacity of Reclaimer 2 (RL2) expressed as a percentage of nominal capacity.

This machine has performed quite well throughout the month and does seem to have an upward trend of utilization, due to its downward trend of idle capacity. At no point did it exceed the 10% threshold. This chart plateaus on 10 Sep during a similar period where another machine is limited. SR6 was underutilized during this time, which suggests that they may have been in conflict.

This machine should be monitored to detect early signs of necessary maintenance in the future.

Stacker-Reclaimers

Stacker-Reclaimer 1 (SR1)

Above, we see an 8-hour moving average of idle capacity of Stacker-Reclaimer 1 (SR1) expressed as a percentage of nominal capacity.

This machine has performed quite well throughout the month and does seem to have an upward trend of idle capacity, suggesting it will require maintenance in the coming months. Periods without data have been correctly accounted for, as they are periods in which the machine was stacking, rather than reclaiming.

This machine should be monitored to detect early signs of necessary maintenance in the future.
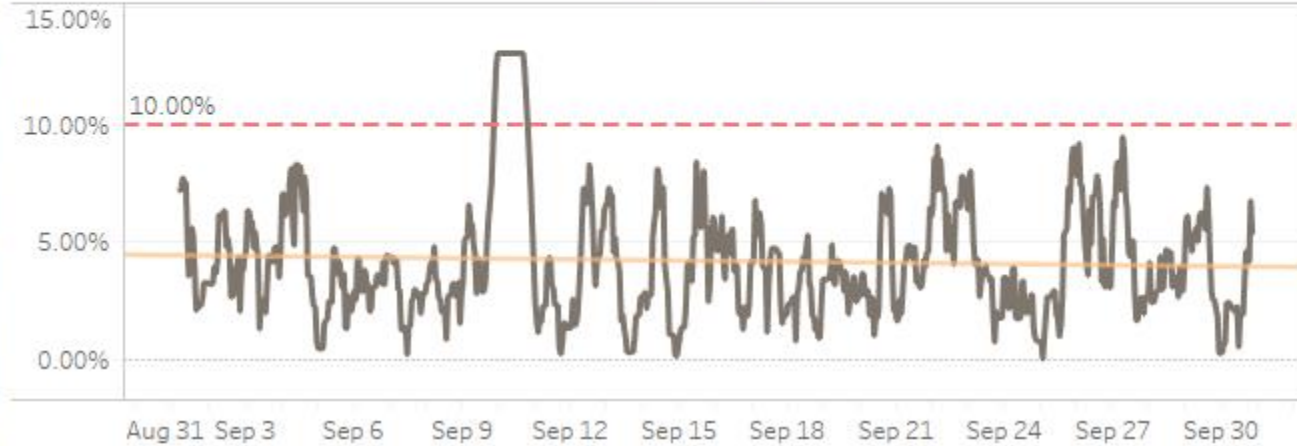
Stacker-Reclaimer 4A (SR4A)

Above, we see an 8-hour moving average of idle capacity of Stacker-Reclaimer 4A (SR4A) expressed as a percentage of nominal capacity.

This machine has similarly operated as a stacker during two periods of the month, but the alarming discovery is that this particular machine has a quickly increasing idle capacity, suggesting that it will exceed the 10% threshold within the next month. The trend is increasing at approximately .12% per hour, suggesting that it will become increasingly more expensive for the mining company if repairs are not conducted as soon as possible.

This machine should be flagged for repair and monitored for further defects.

Stacker-Reclaimer 6 (SR6)

Above, we see an 8-hour moving average of idle capacity of Stacker-Reclaimer 1 (SR1) expressed as a percentage of nominal capacity.

This machine has performed quite well throughout the month and does seem to have an upward trend of idle capacity, suggesting it will require maintenance in the coming months. The discrepancy noted on 10 Sep can be attributed to the concurrent maximum output of RL2, which has a similar event during this time period. This false positive should not flag the machine for maintenance.

This machine should be monitored to detect early signs of necessary maintenance in the future.

Conclusion

RL1 should be flagged for maintenance, as it has exceeded the 10% idle capacity threshold four times, and has an increasing trend of under utilization.

SR4A should also be flagged for maintenance, where although it has not exceeded the 10% threshold, the high trend of undertutilization will become more costly over time.

RL2, SR1, and SR6 are performing within standards, and should continue to be monitored.