

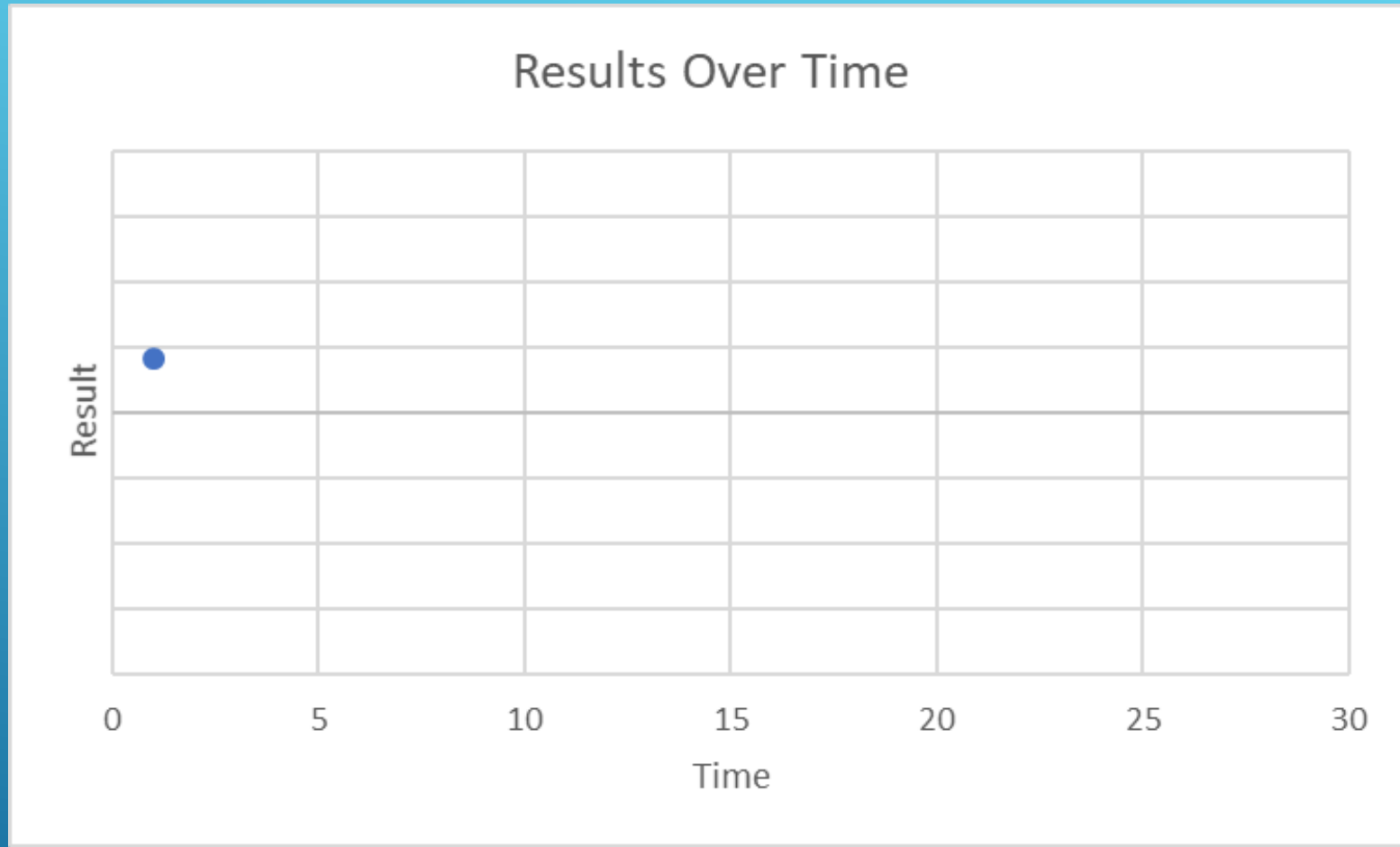
ESTABLISHING STATISTICAL PROCESS CONTROL IN FOOD MANUFACTURING

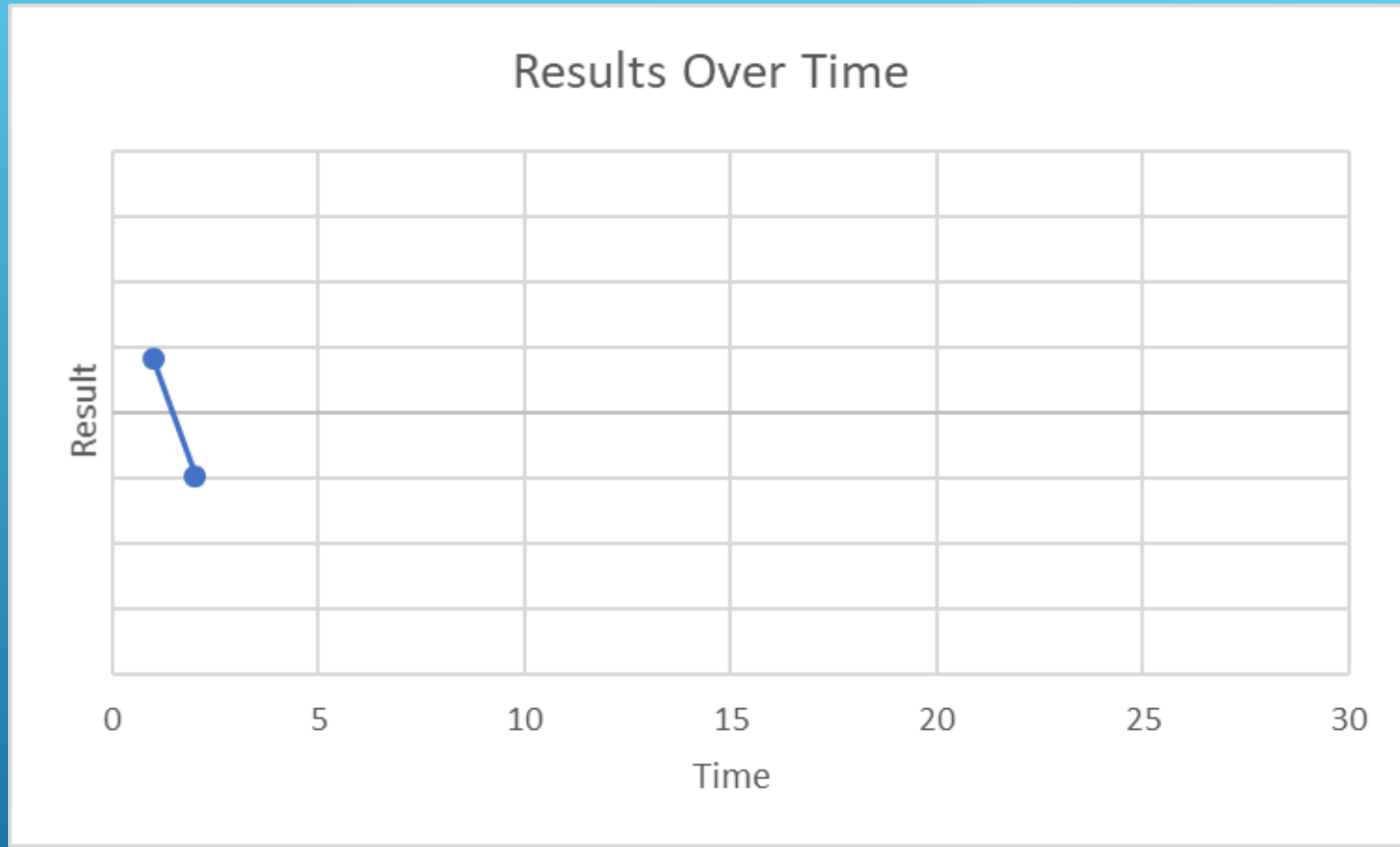
Using control charts to maintain process
performance

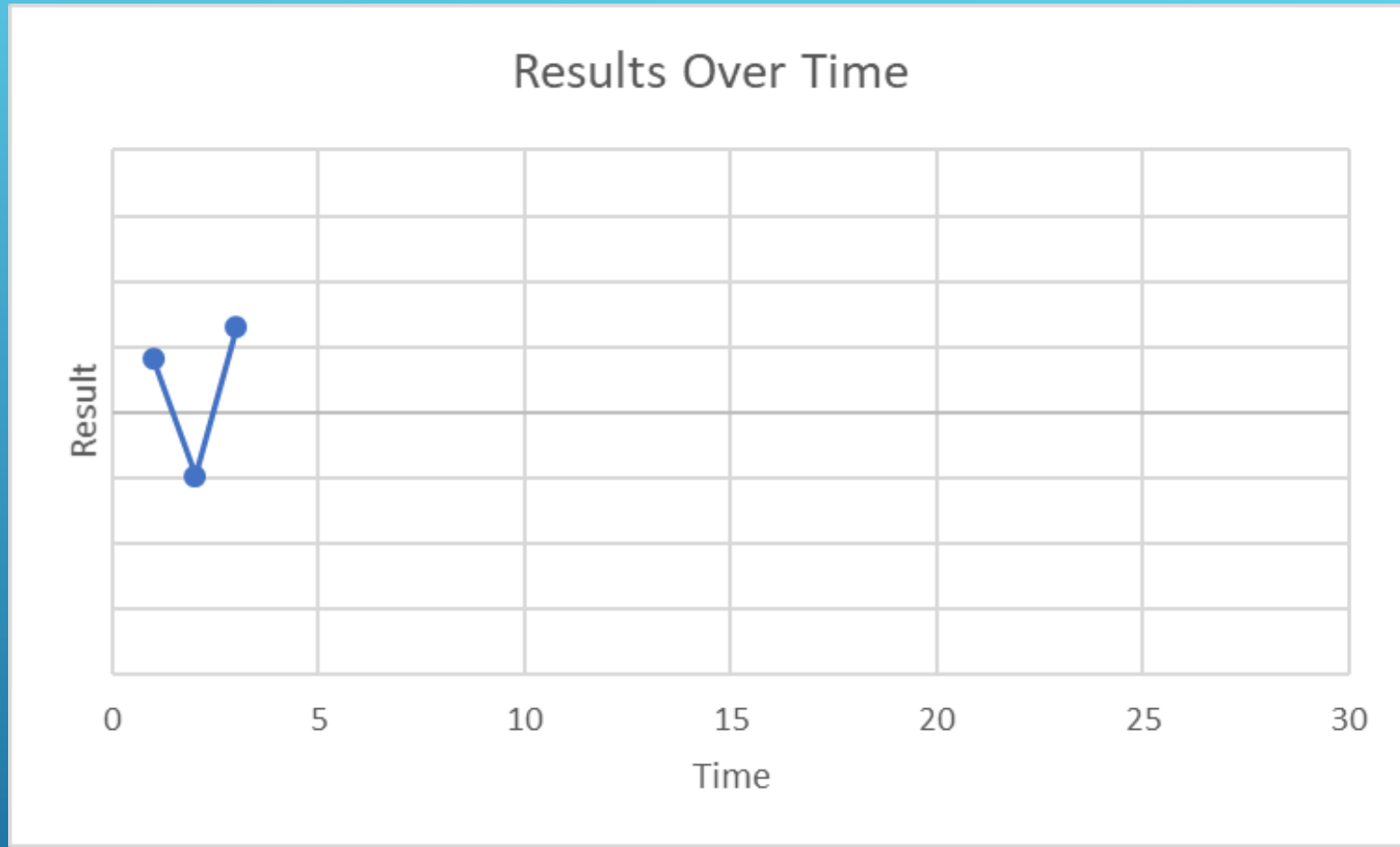
Control Charts

Developed in 1924 by Walter Shewhart

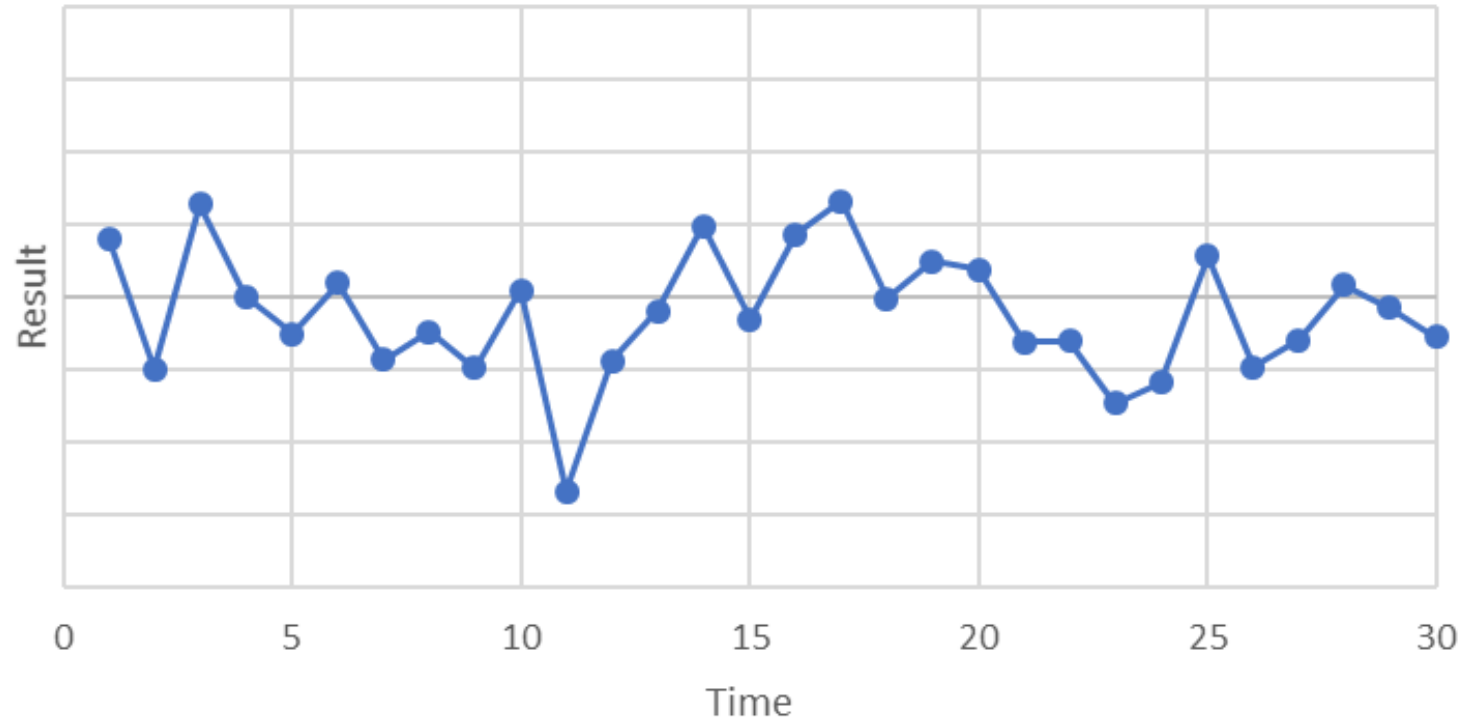
- ▶ Basic approach:
 - ▶ Understand how much variation is inherent in the process
 - ▶ Monitor process results, ideally in real time
 - ▶ If results are not as expected, react accordingly
 - ▶ If results are as expected, leave the process alone
- ▶ The control chart doesn't tell you what has changed but, simply, that something has changed

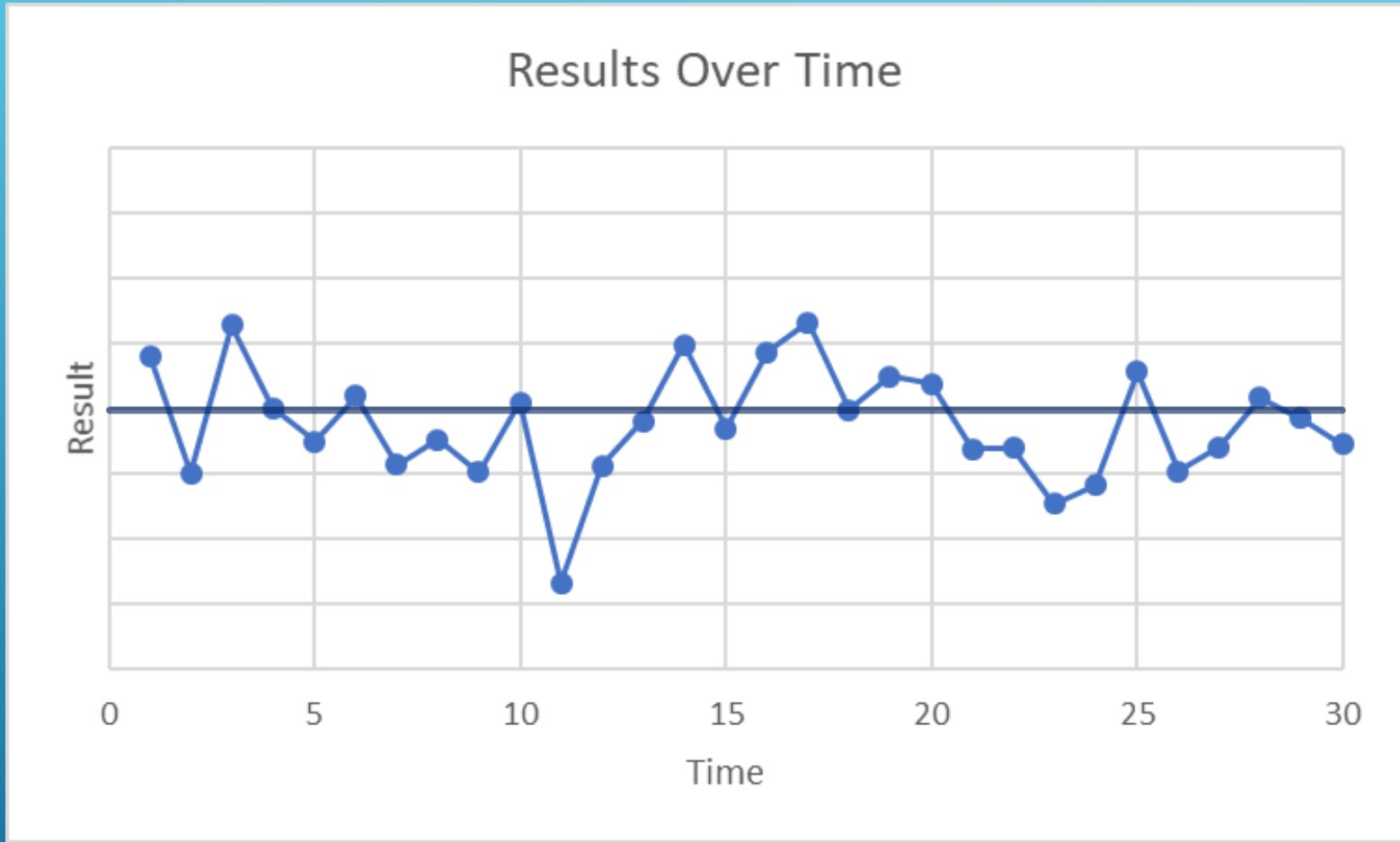






Results Over Time





Target or Historical Average

Shewhart divided process variation into two broad categories:

- ▶ Natural variation
- ▶ Uncontrolled variation

Natural Variation

- ▶ Present in the process at all times
- ▶ The variation that you can't (or choose not to) account for or eliminate
 - ▶ It's just part of the process
- ▶ a.k.a, inherent variation or random variation
- ▶ Examples:
 - ▶ Variation in the measurement process
 - ▶ Product temperature variation due to variation in piece size

Uncontrolled Variation

- ▶ Only present some of the time
- ▶ It's due to something special that's not part of the process
- ▶ a.k.a., assignable cause variation or special cause variation
- ▶ Examples:
 - ▶ Variation due to differences between lots of raw materials
 - ▶ Variation caused by using a different procedure
 - ▶ Variation resulting from equipment wear or failure

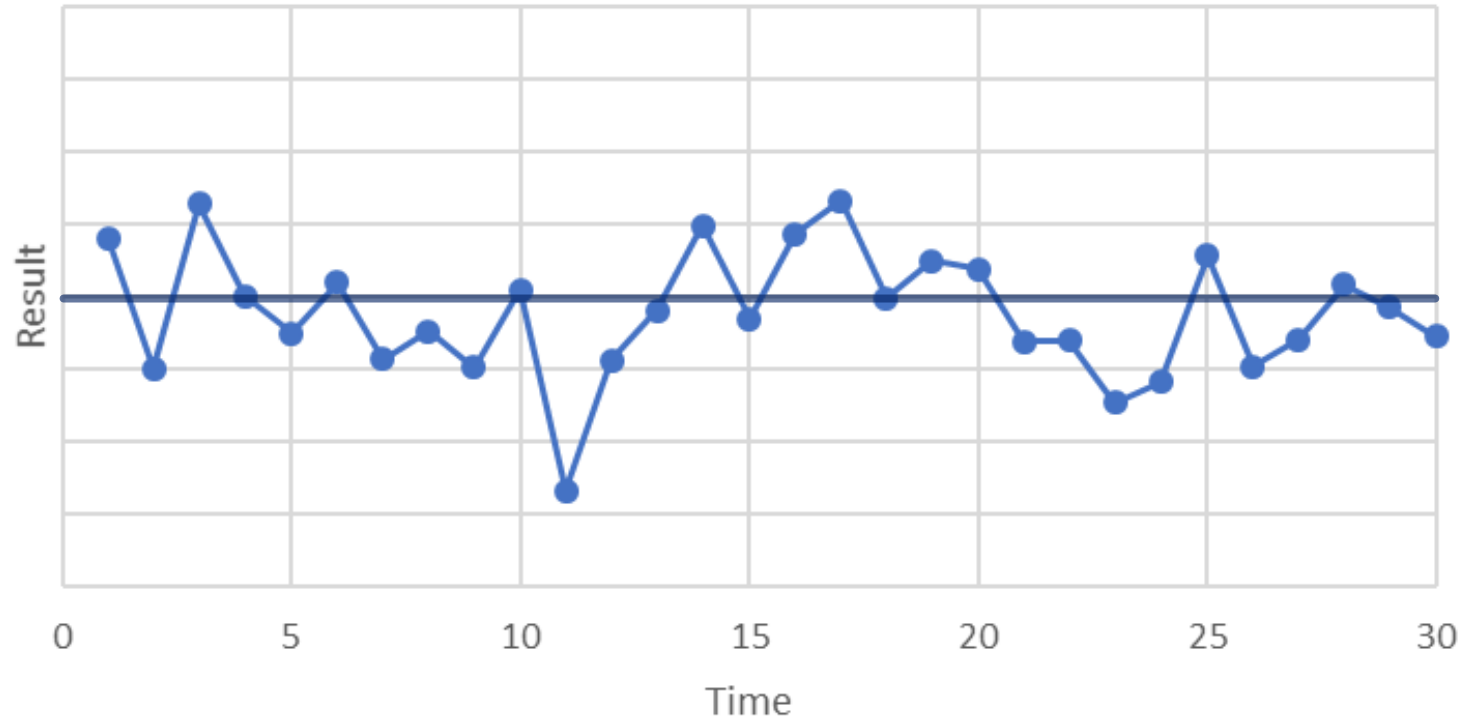
Control Limits

- ▶ Use process data to calculate upper and lower limits that represent bounds of process variation that would be expected in the absence of uncontrolled variation
- ▶ The equations used to calculate the control limits depend on the type of data being collected
 - ▶ Measurements
 - ▶ Counts
 - ▶ Proportions or percentages
- ▶ For measurements, the calculations also depend on the number of measurements per sample

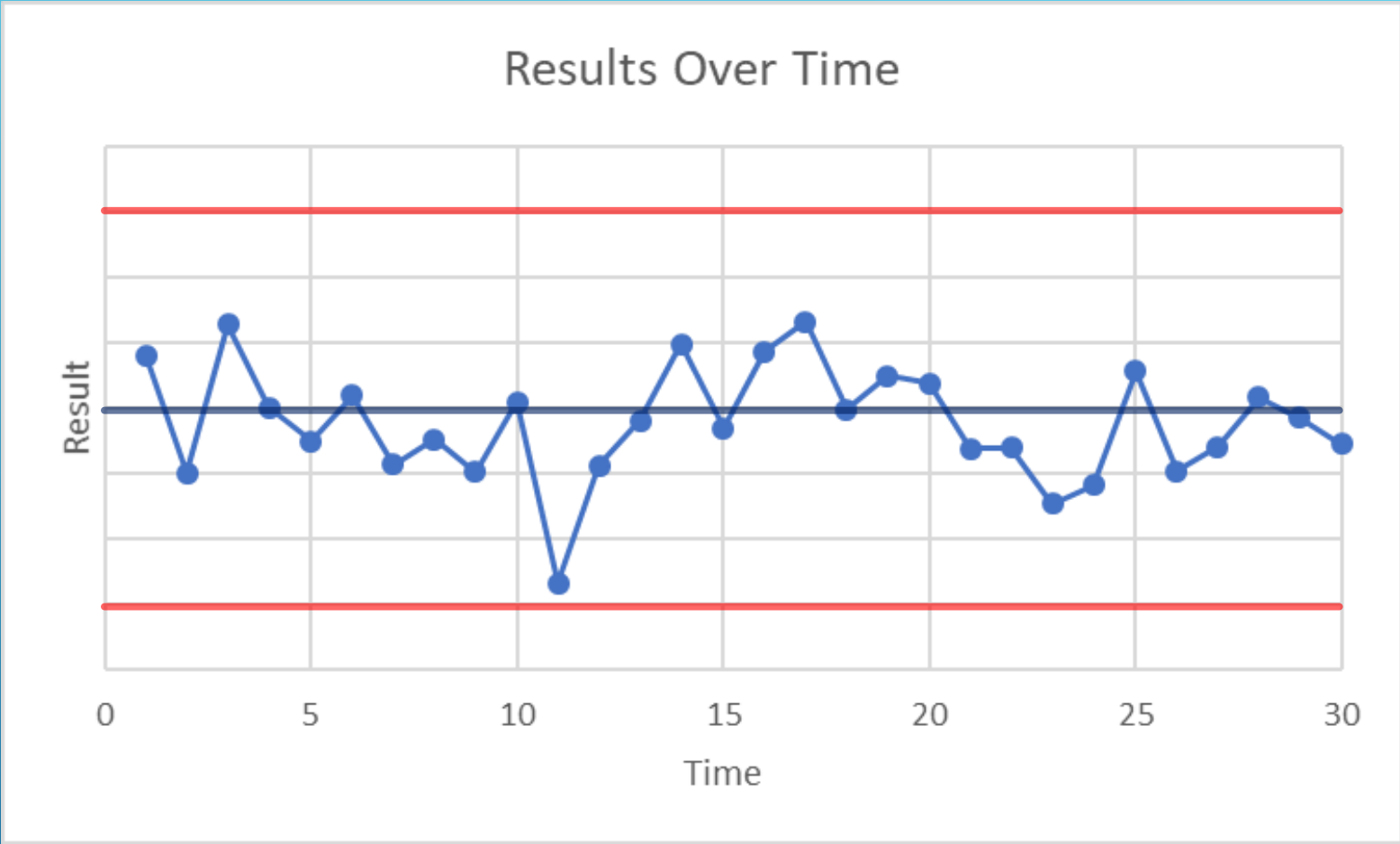
Control Limits

- ▶ Control limits are usually set so that the chance of getting a false signal is approximately 3/1000
 - ▶ This can be adjusted based on risk tolerance and the consequences of operating off-target
- ▶ It is recommended that a minimum of 30 samples be used to calculate the control limits
- ▶ Once control limits are established, leave in place until there is a significant change in the process

Results Over Time



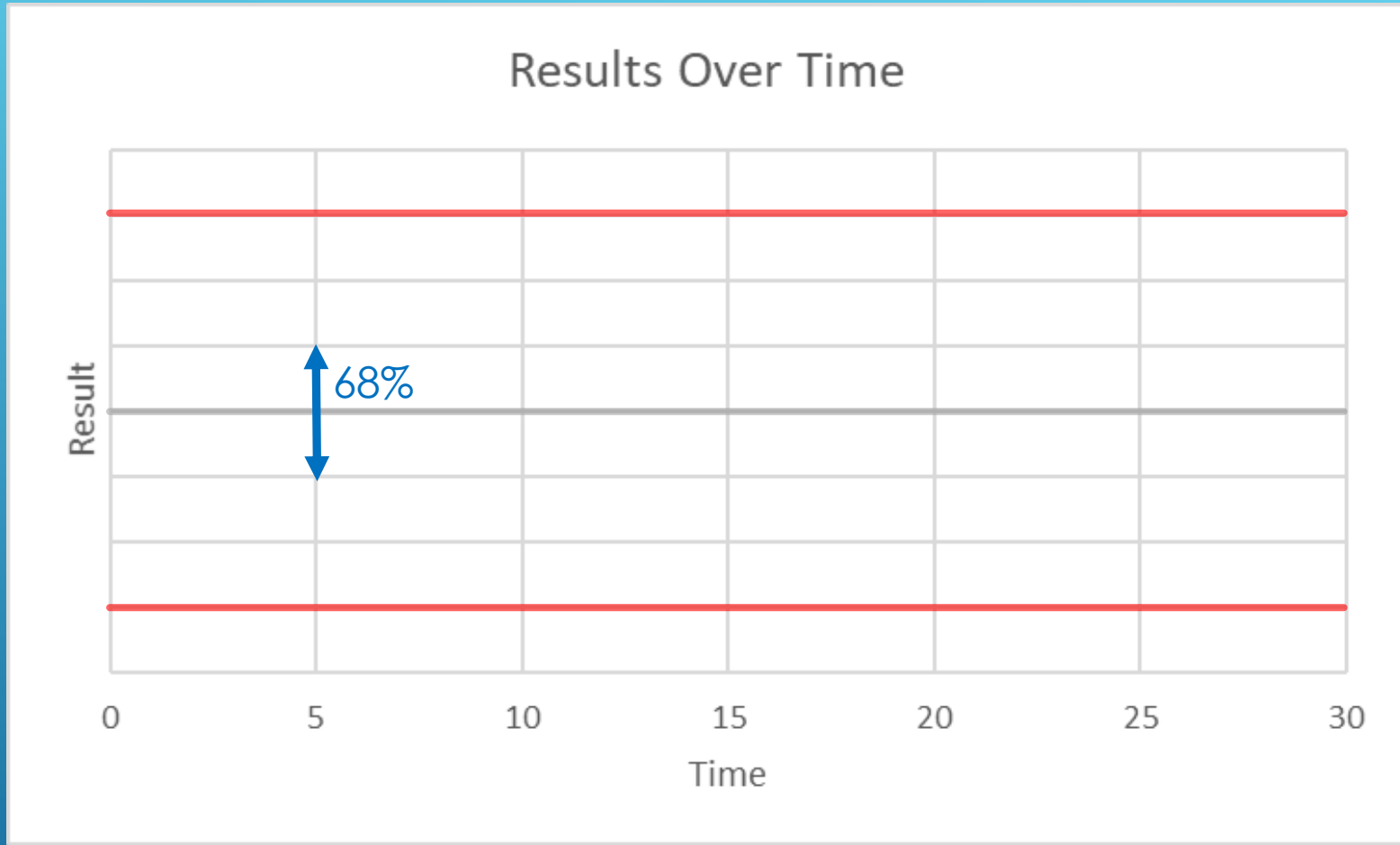
Target or Historical Average



Upper Control Limit

Target or Historical Average

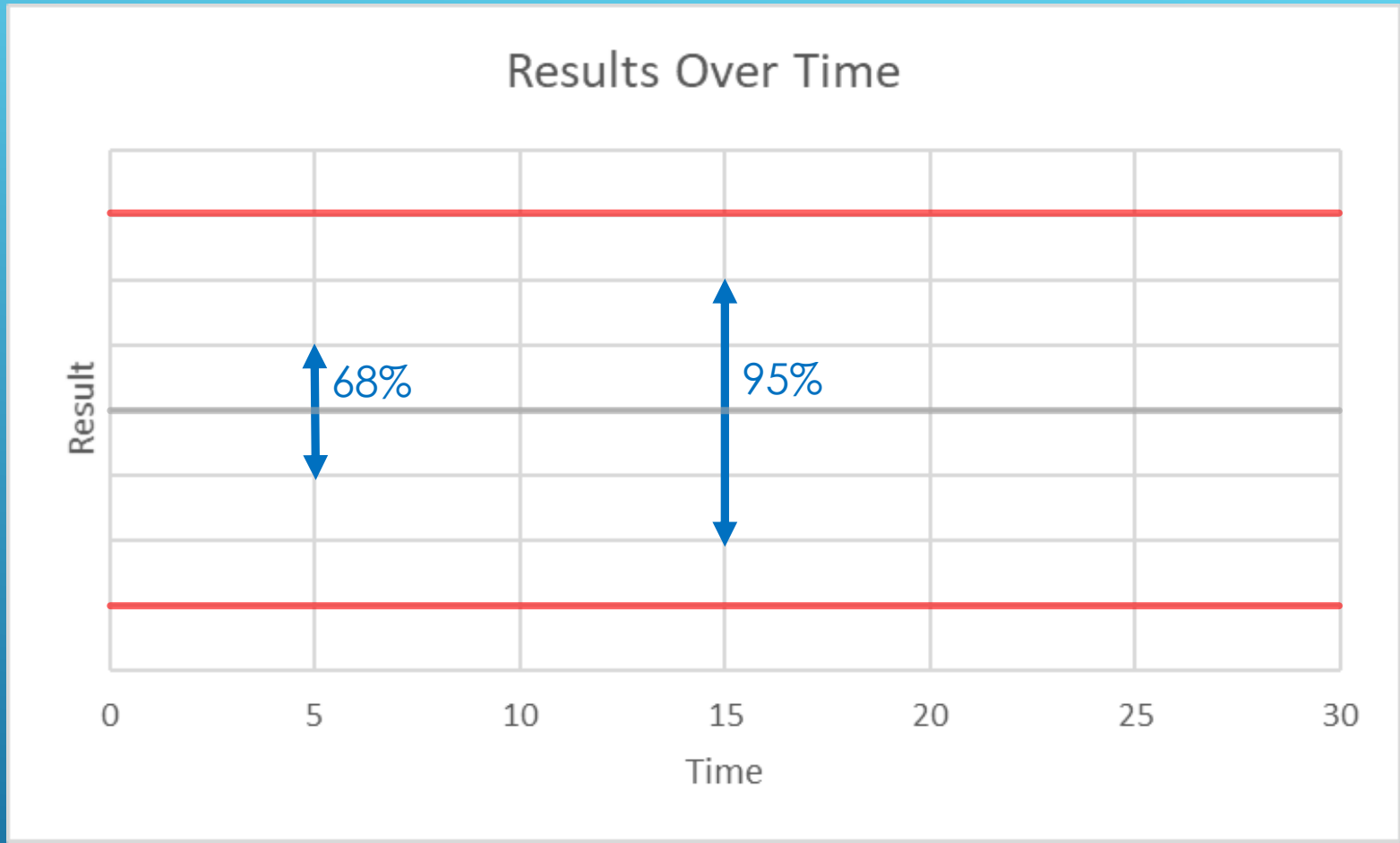
Lower Control Limit



Upper Control Limit

Target or Historical Average

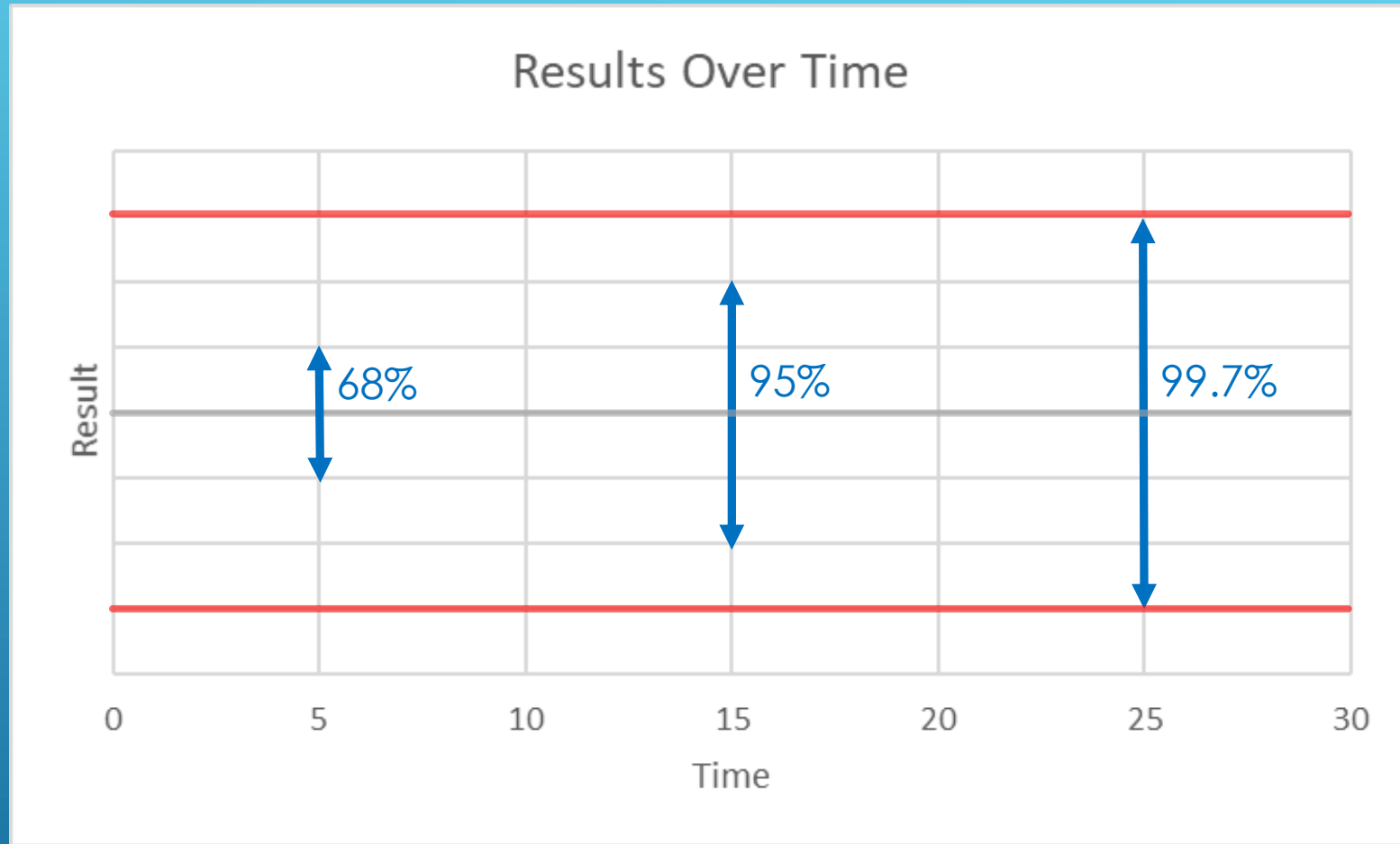
Lower Control Limit



Upper Control Limit

Target or Historical Average

Lower Control Limit



Upper Control Limit

Target or Historical Average

Lower Control Limit

Two Control Charts?

In the case of measurement data there are, typically, two control charts:

- ▶ One control chart to monitor the process location (the average of the measurements)
- ▶ A second control chart to monitor the amount of variation within sample sets or between consecutive samples

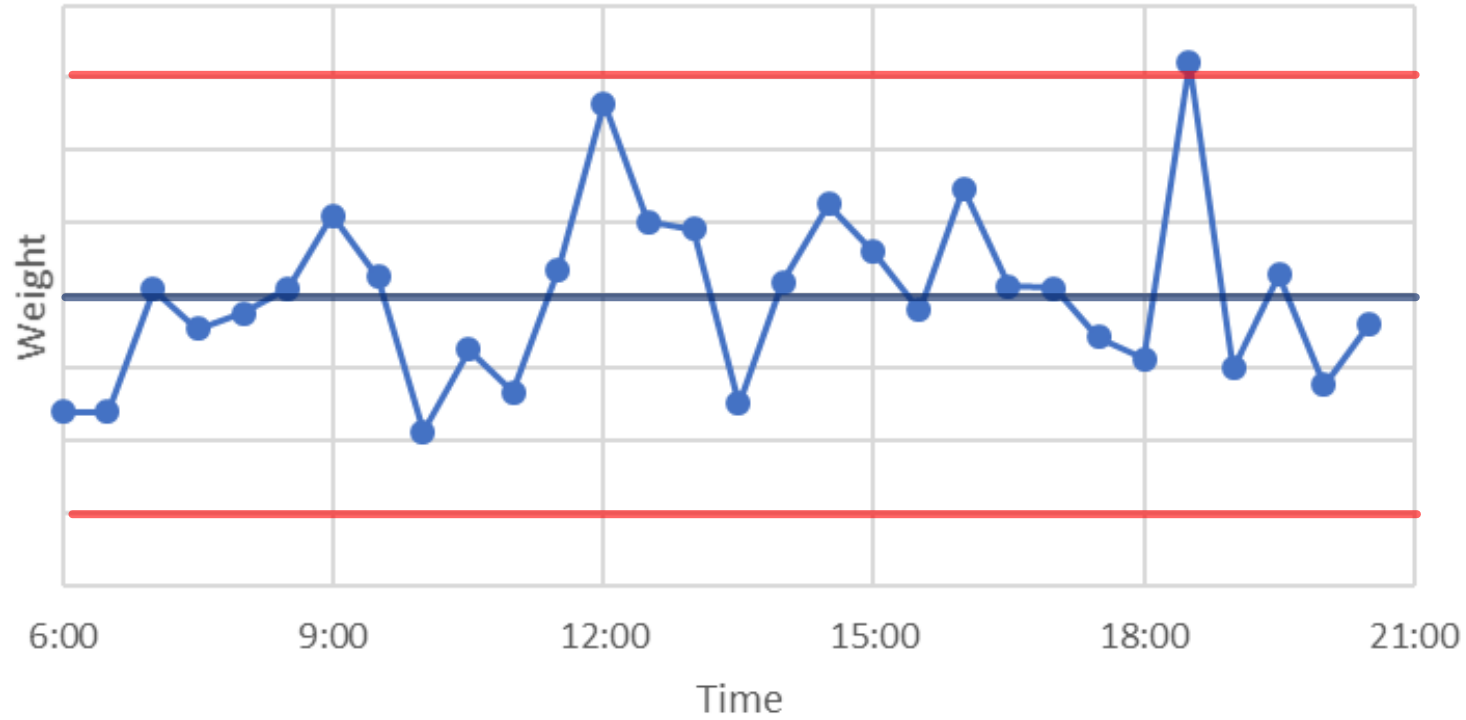
Control Chart Examples

STATISTICAL PROCESS CONTROL

A decorative graphic consisting of several parallel white lines of varying lengths, slanted upwards from left to right, located in the bottom right corner of the slide.

Rob Glennon
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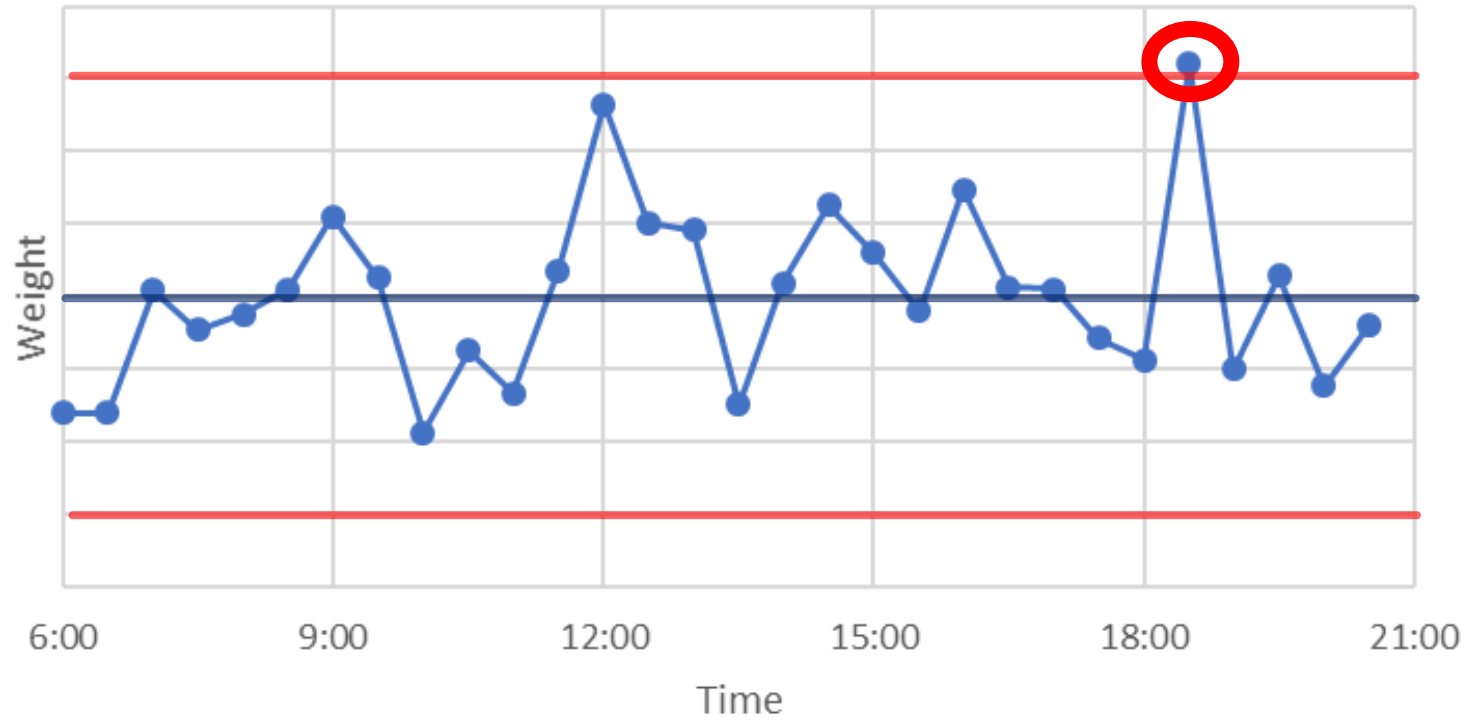
Average Piece Weight



UCL

LCL

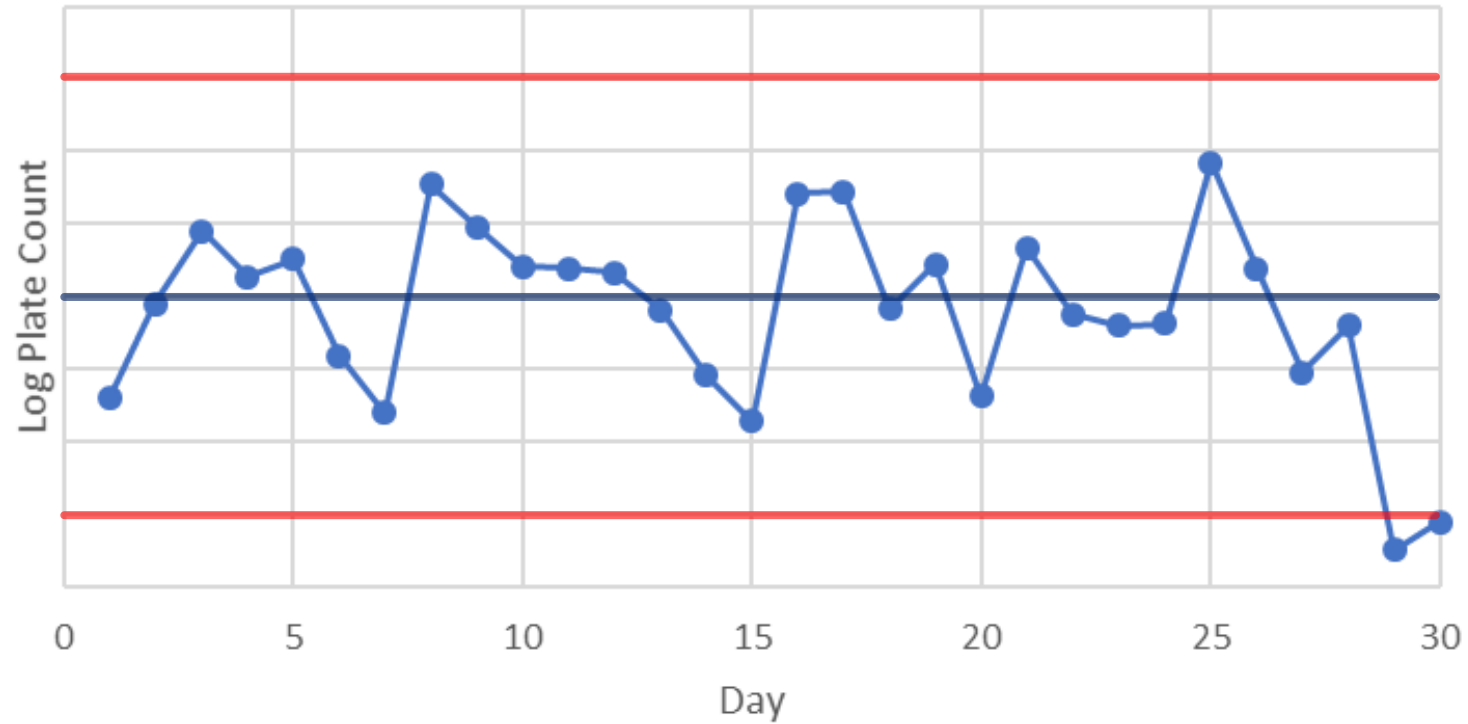
Average Piece Weight



UCL

LCL

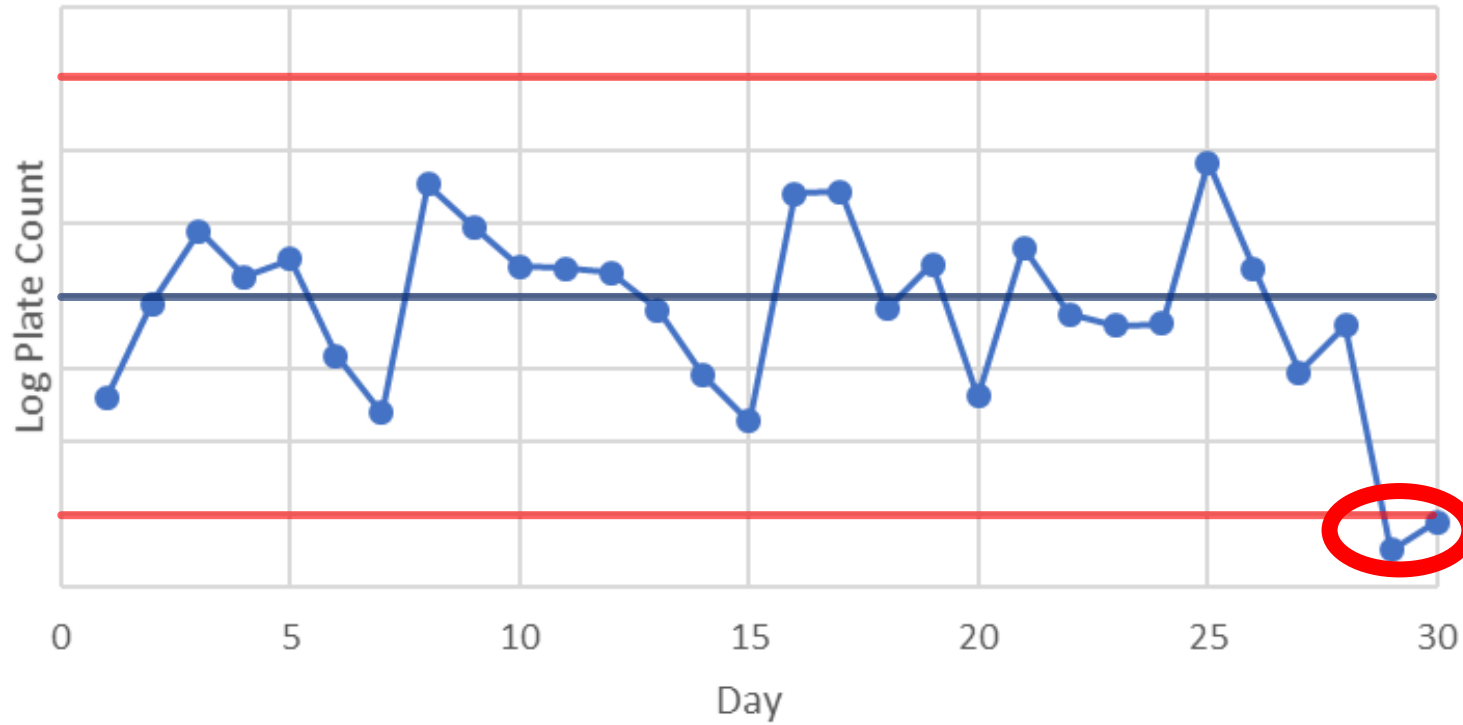
Total Plate Count, Site 15A



UCL

LCL

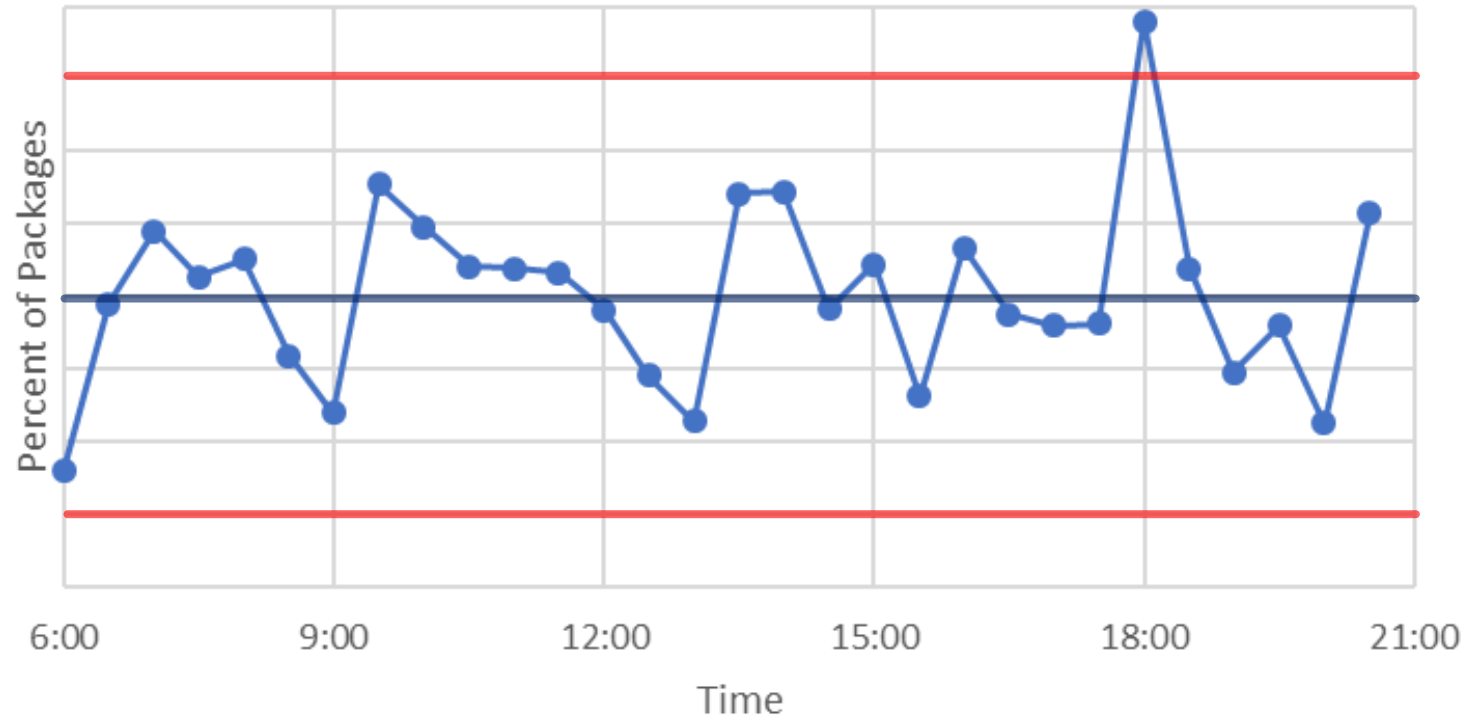
Total Plate Count, Site 15A



UCL

LCL

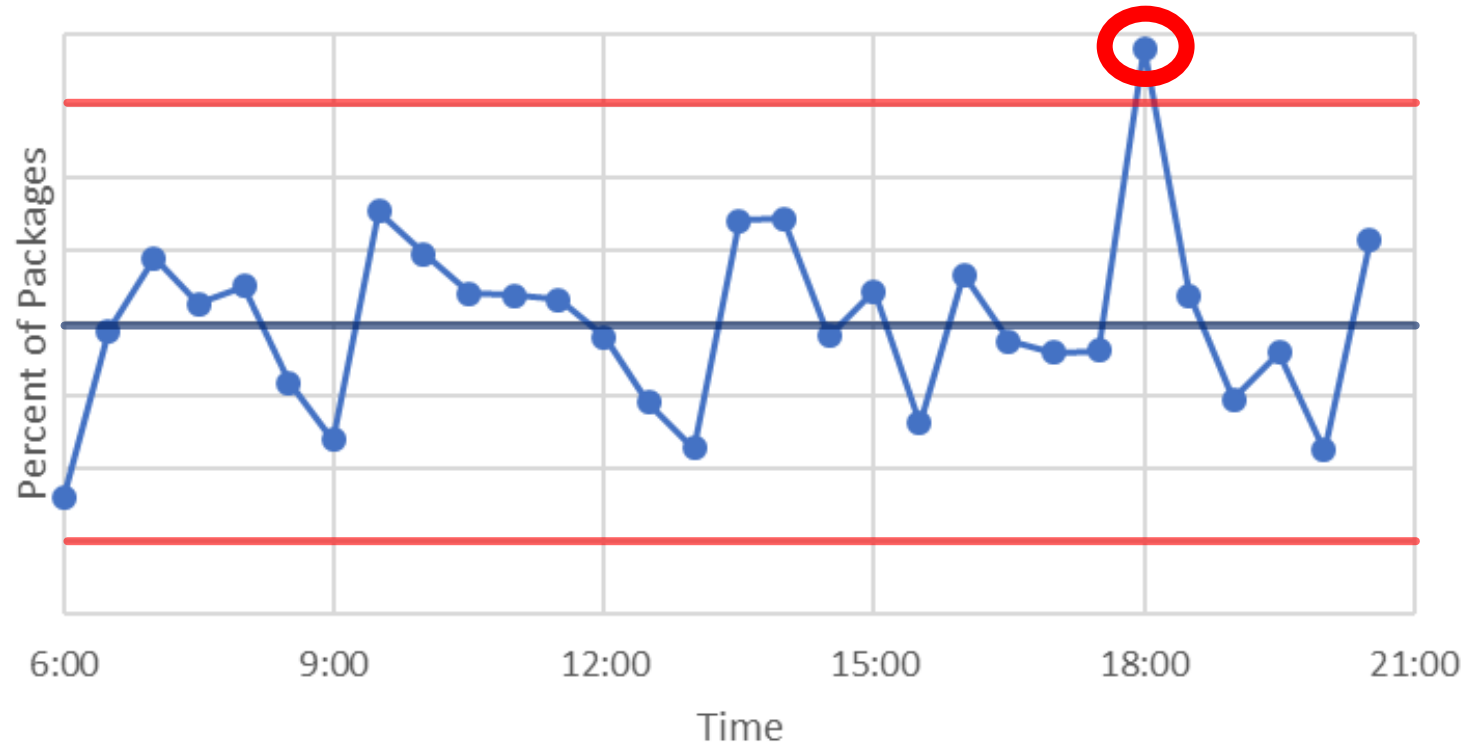
Metal Detector Kick-Outs, South Line



UCL

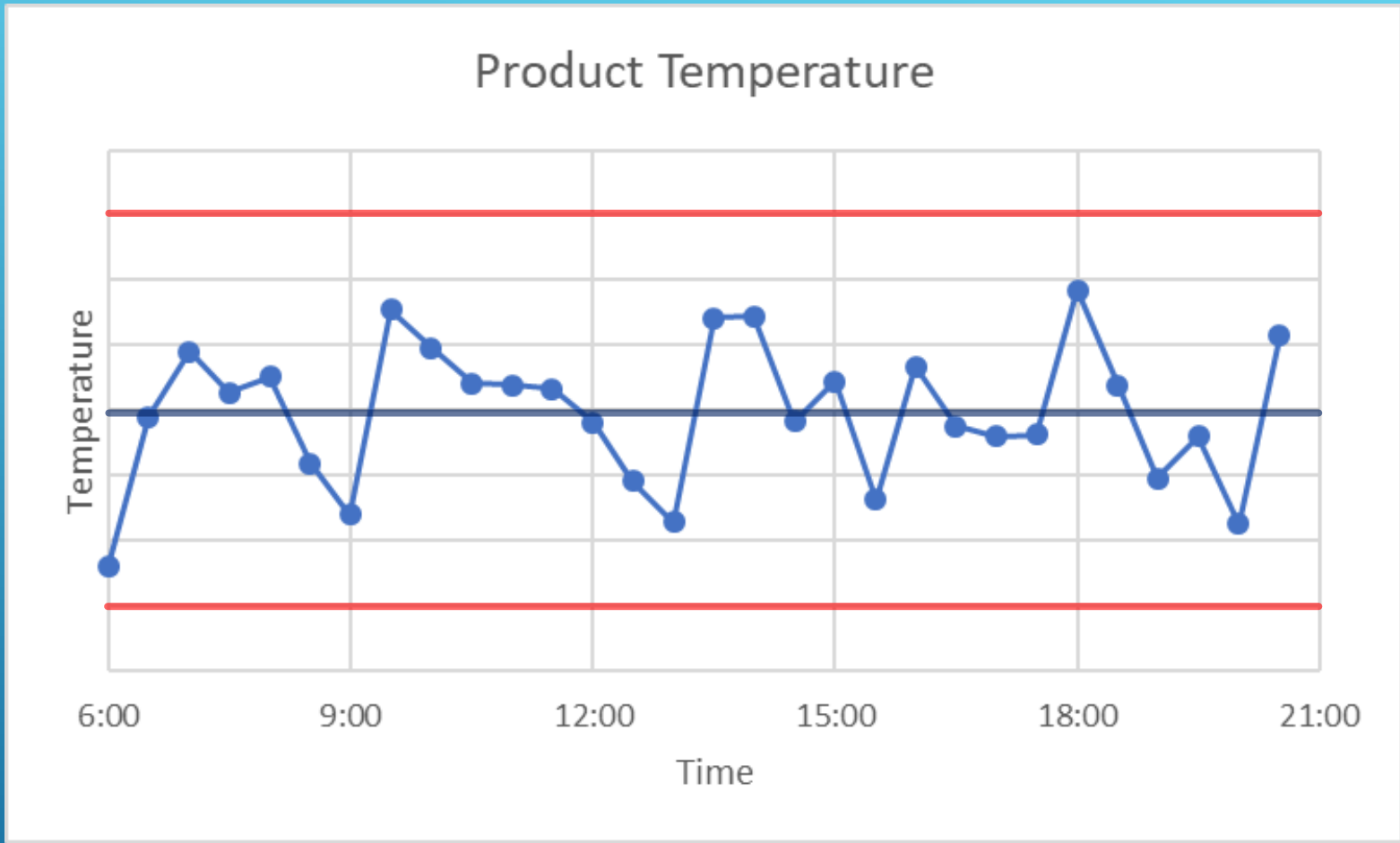
LCL

Metal Detector Kick-Outs, South Line



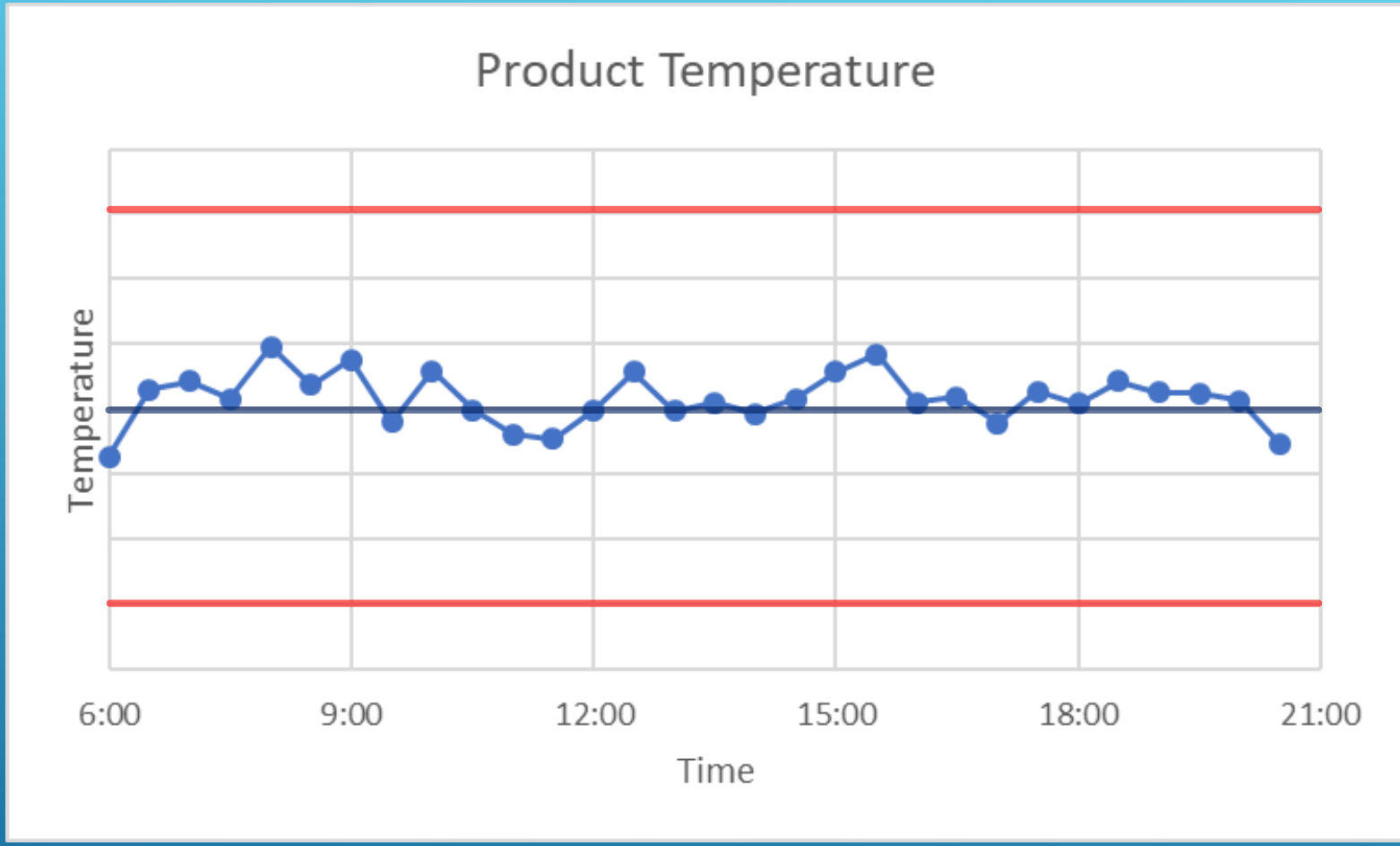
UCL

LCL



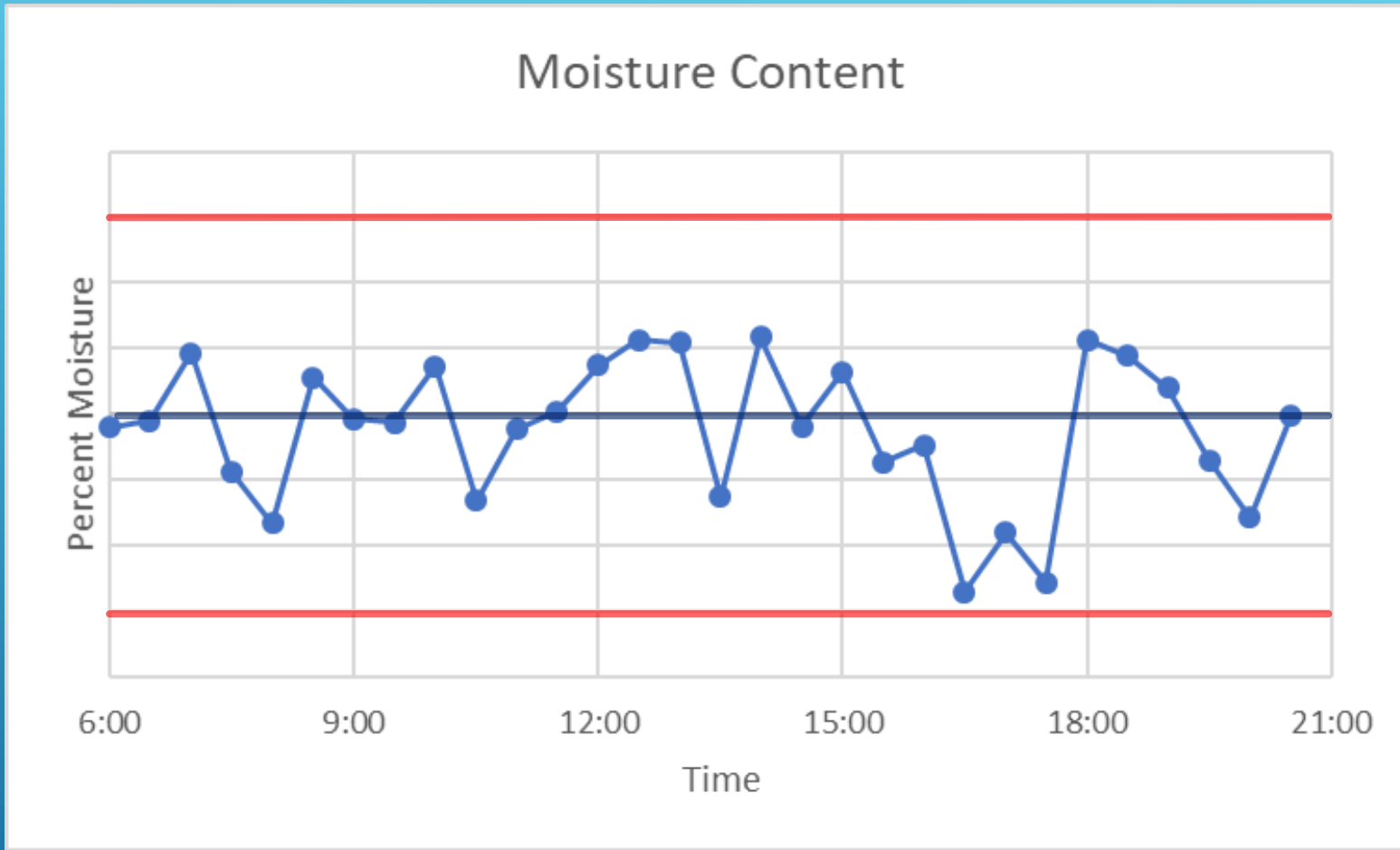
UCL

LCL



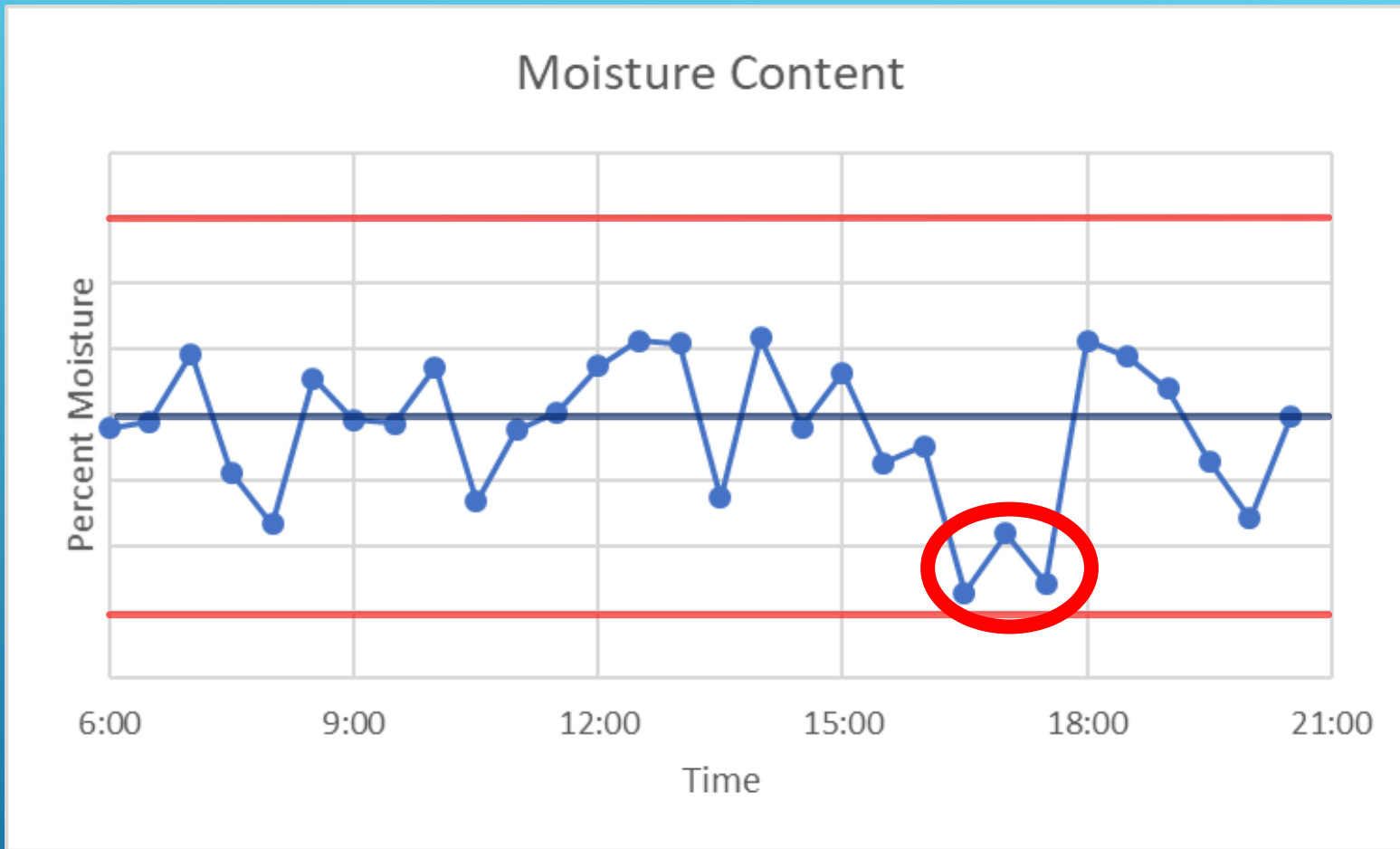
UCL

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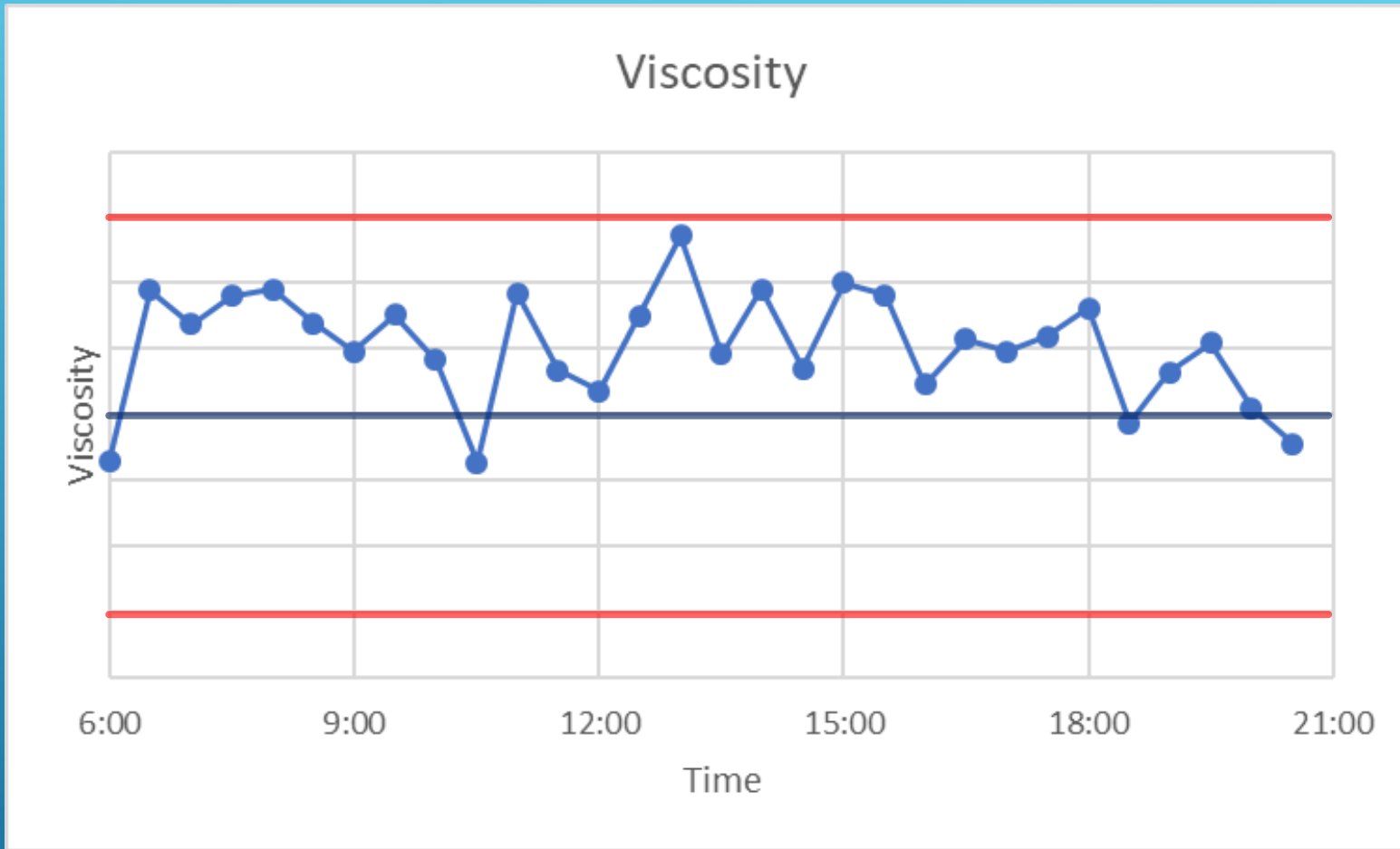
UCL

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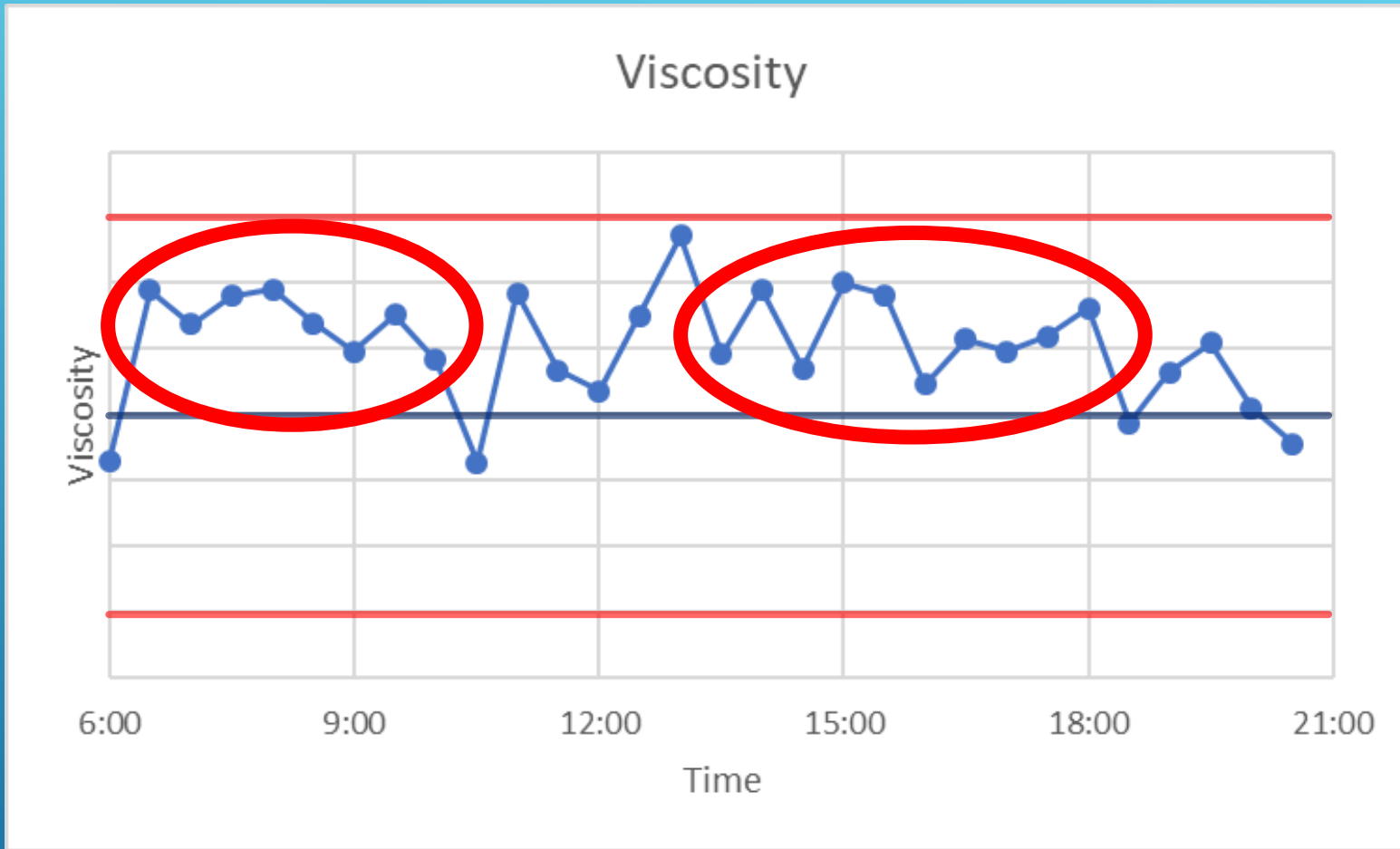
UCL

LCL



UCL

LCL



UCL

LCL

Run Rules

The three previous examples highlight the benefits of incorporating run rules.

- ▶ Some commonly accepted run rules:
 - ▶ Eight consecutive points on the same side of the center line
 - ▶ Two of three points in the outer third of the area above or below the center line
- ▶ Each of the run rules are designed to have a false signal rate similar to that of a single point being outside the control limits

If I'm measuring something like temperature, wouldn't it be easier to just adjust the process back to target after each sample?

- ▶ In the absence of a special (hopefully unusual) cause of variation, you are just reacting to variation that is inherent to the process
- ▶ This type of over correction will actually increase the amount of variation in the process – approximately double.
- ▶ It's a lot of extra work for the operator

Questions?