Team 8 Project Final Report:

Improving Measurement Consistency and Process Capability: Analyzing Ppk values for DeeZee's Ford Running Boards

I.E. 3610
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Iowa State University

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Date: December 13th, 2024
To: DeeZee Engineering Team, Dr Michael Dorneich
From: Braden Skaggs, Ryan Nagao, Youngjae Cho, Jacob Roberts
Iowa State University IE 3610 Project Team
Subject: IE 3610 Project Final Report and Recommendations

To Whom it may concern,

The purpose of this report is to speak on the findings of the IE 3610 Team from Iowa State University from the team's project regarding the Ford Running Boards and Ppk meeting. After analyzing the data, running experiments with the board data, and documenting the results, the team provides a list of recommendations below regarding the project and the results the team came up with.

The following report details the team's findings regarding the Ford Running Boards and the historical data the team gave to analyze. The team formed Ppk graphs over time, conducted Gauge R&R studies, and looked into the historical data to see if the team could eliminate any anomalous points in the data that were issues with loading the part.

From these studies, the team has found several points on the running boards that tend to have the lowest Ppk graphs in the analyses. Given these points and the data listed below regarding these points, the team has provided various solutions to hopefully work on improving these Ppk graphs over time. These solutions include operator standardization and training, calibration of the data collection system, restructuring of the table orientation, and creation of a Go/no go gauge for assisting with measuring laser cut areas in metal. Additionally, as a recommendation, the team can provide the R studio code used to develop the Ppk graphs so engineers at DeeZee can continue analyzing other historical data they have.

The team has enjoyed their time working with the DeeZee engineering team and working on this project. Feel free to contact any of the team members with any further questions. Thank you for your time and cooperation with this project.

With Regards,

Iowa State University IE 3610 Team 8

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Introduction

In March 2025, DeeZee will meet with their Ford Motor Company partners regarding the Ppk of various parts that the operators have measured throughout the past four years. DeeZee is working on consolidating various histograms and charts to show an improvement in the quality of their parts and their conformance to the required tolerances and specifications set by Ford Motor Company, as well as the process control variables required by Ford Motor Company. This Ppk value is set at 1.33 by Ford Motor Company and Dee Zee themselves.

After analyzing historical data on two parts in particular and reviewing DeeZee's processes, the team found many sections of these parts that fall under the 1.33 Ppk value set. Specifically, the team found that 24 out of the 44 given measurement values (22 points x 2 parts) do not reach the targeted Ppk threshold. In discussion with the team from DeeZee, the team also found that specific low Ppk measurements were associated with points susceptible to reproducibility variation for various reasons.

Part measurement apparatus at DeeZee

Methods

Based on the problem description by the engineers at DeeZee, there were two main methods the team decided to focus on: how to analyze historical data, and ways to improve areas of potential nonconformity. Given the project's scope and various time constraints, these two avenues of investigation seemed the most efficient and widely applicable to processes outside of this project.

The historical data spans almost four years, from January 2020 to October 2024. After loading a part onto a specially designed platform, the operators use a laser gauge to measure each of the 22 features per part, and these measurements are then automatically collected and put into a spreadsheet. In addition to the measurements, there are also variables for part identity (such as barcode number), date and time, and engineering specifications. There are two notable gap periods within this data: the COVID-19 lockdown and the time when the data collection system was unintentionally disconnected. These periods are around four months long, in 2020 and 2023 respectively. In total, there are 4089 observations with 137 variables.

To supplement the current analytical tools at DeeZee, it was essential to figure out existing limitations in their systems. It has been set up that many of the values and visuals valid for analysis are already being calculated. Summary statistics like mean, standard deviation, graphs for distributions, and control charts are created automatically. There are also calculated Ppk values that helped to see initially where process capability issues might exist. However, many of these outputs are limited to 30 observations, while they are looking for analysis over the entire four-year period.

Using RStudio, the team created scripts that would perform these various four-year analyses. Given the specific request of Ford Motor Company, the initial script created a graph visualizing Ppk over the four years. This script would help the engineers at DeeZee see the trajectory of Ppk across the 44 features and assess whether a feature was progressing in a positive or negative direction (Figure 1).

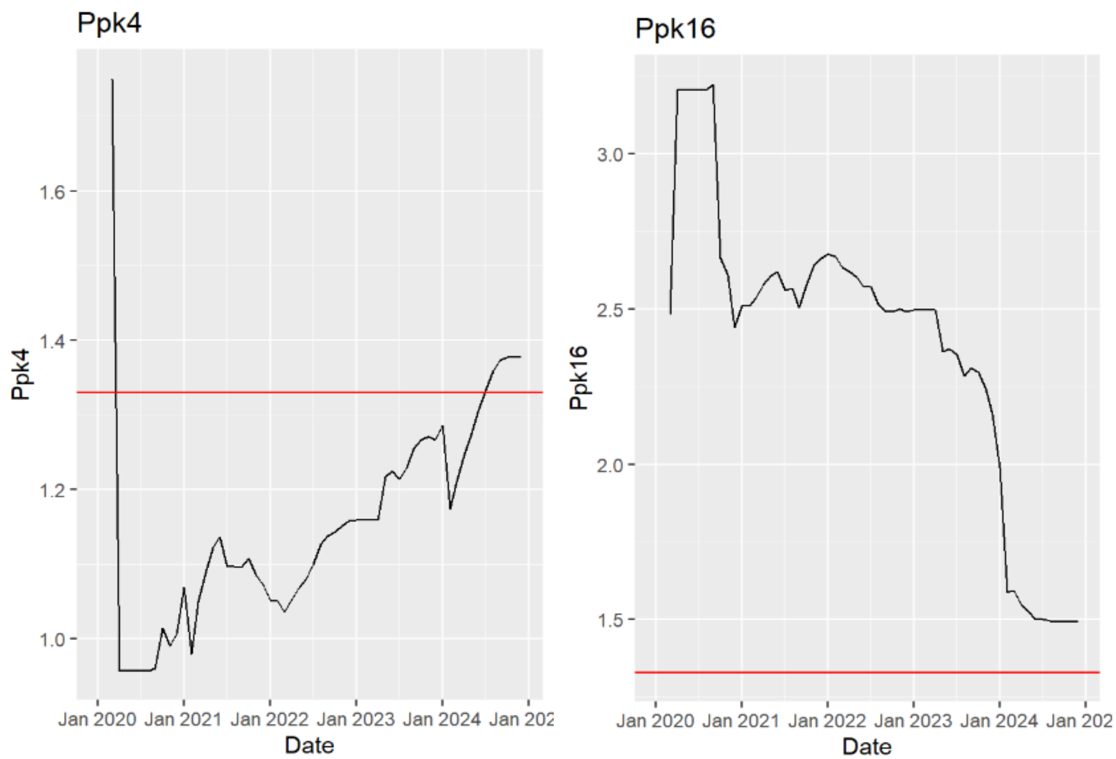


Figure 1: Feature with positive trajectory (left), feature with negative trajectory (right)

Following the creation of the Ppk graphs and subsequent discussions with the engineers at DeeZee, it became clear that there were observations in the data with extreme measurement values that were impacting any calculations not robust to these outliers, including Ppk. Using RStudio, the team found these extreme values in two different ways.

The first method was by looking at whether or not a feature from a part was within engineering specifications, based on a pass-fail variable that existed within the provided data. The team found one observation per part with over 20 features outside of specifications, which were then deemed anomalous.

The second method involved more statistical intuition. Each of the 44 features comes from a normal or approximately normal distribution. With this being the case, the team wanted to assess the existence of observations more than three standard deviations from the mean. To visualize this, the team created retrospective control charts spanning four years (Figure 2). The team decided to consider parts with ten or more out-of-control features anomalous.

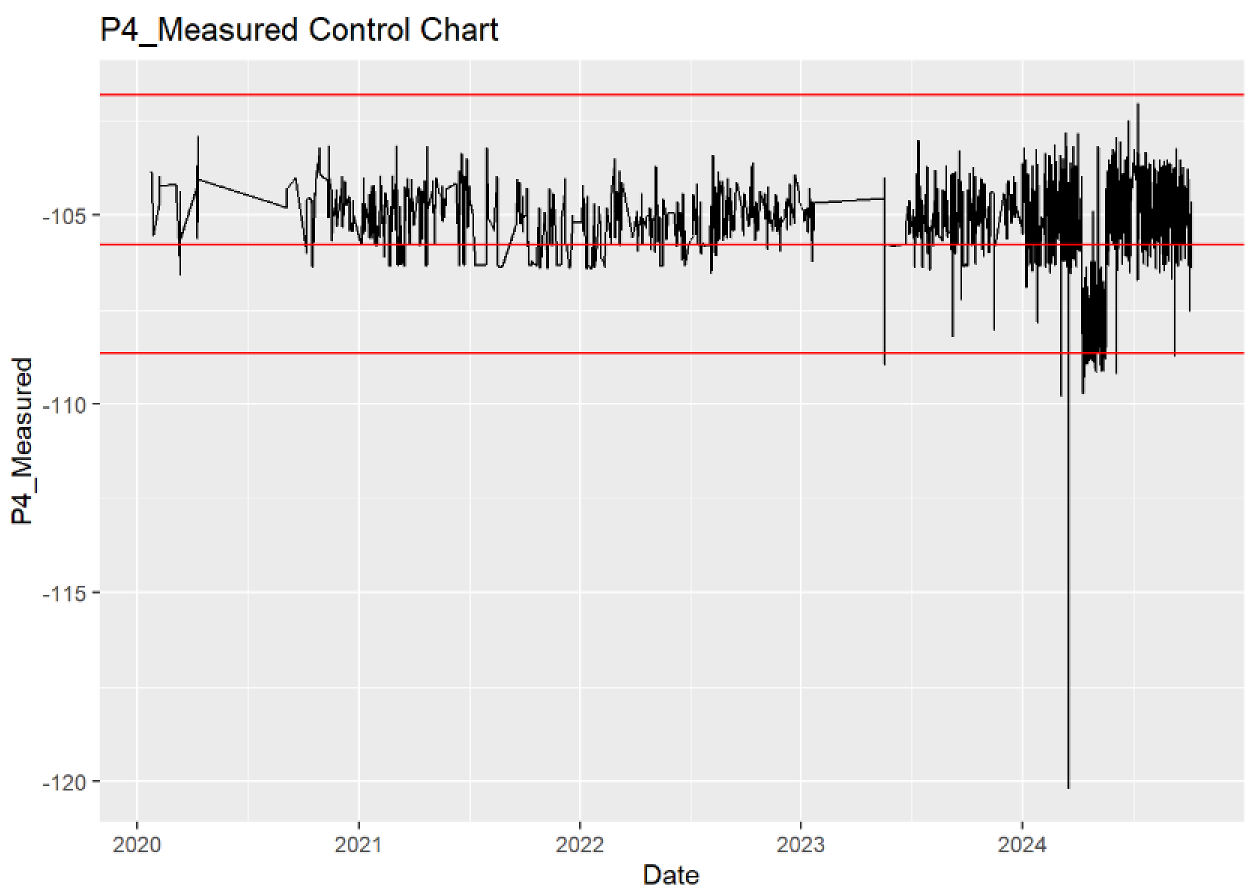


Figure 2: Retrospective control chart showing extreme observations

Parallel to the historical data analysis was a Gauge R&R intended to assess variation in the measurement of the parts. With the physical acts of loading the part on the measurement station and using the laser probe, it was deemed highly possible that variation was being added to the measurements outside of random noise.

A first Gauge R&R was conducted with team members present to observe, with follow-up experiments undertaken in-house by the engineers at DeeZee. The initial study saw four operator groups measuring ten different parts. The results were then processed and visualized. In addition to assessing sources of variation, two of the selected parts were also intentionally out of specification to see if false flags for good or bad parts were possible. Further studies by DeeZee corroborated the results of the first.

Results/Discussion

After discussing the extreme measurements with the engineers from DeeZee, it was decided that it would be helpful to see these values' visual impact on the data. As such, the script that generated the Ppk graphs was updated to show before and after removing these observations from the data. Five total observations were removed from the criteria established by the team, three from one part and two from the other (Figure 3), and the graphs were generated with this change (Figure 4).

P702Idnty <dbl>	numnonconforming <dbl>
5878	21

P702Idnty <dbl>	numoutoflimits <dbl>
5655	12
6030	11

P702Idnty <dbl>	numnonconforming <dbl>
4990	22

P702Idnty <dbl>	numoutoflimits <dbl>
6466	14

Figure 3: Tabular output of extreme value detection methods

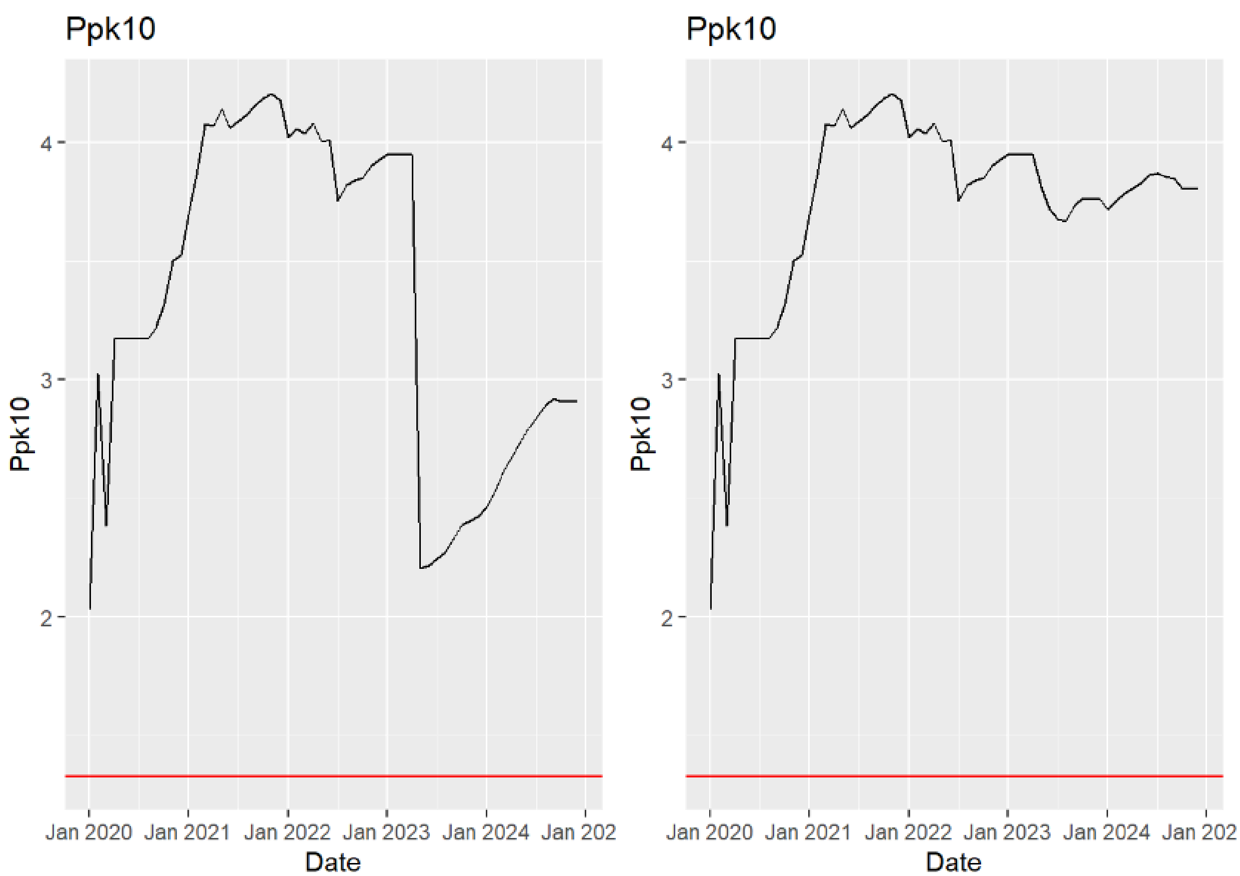


Figure 4: Before/after Ppk graphs showing the influence of extreme observations

It becomes evident that these extreme observations have the potential to significantly impact how various values are calculated, most relevantly Ppk. However, their removal from the considered data is only valid because they come from genuine error rather than being an anomalous yet authentic product of the process. In discussions with the engineers from DeeZee, it was concluded that these measurements most likely came from genuine manual errors, so they were considered as such.

In many of the features, it was also the case that removing extreme observations had little impact on the Ppk (Figure 5). Based on visual judgment, only 16 of the 44 features were determined to have a clear and relevant difference when extreme observations were removed. Even within these different features, there were still examples where the trajectory would be considered harmful (Figure 6). These extreme measurements can only be considered part of the overall problem.

Figure 5: Before/after Ppk graphs showing little influence of extreme observations

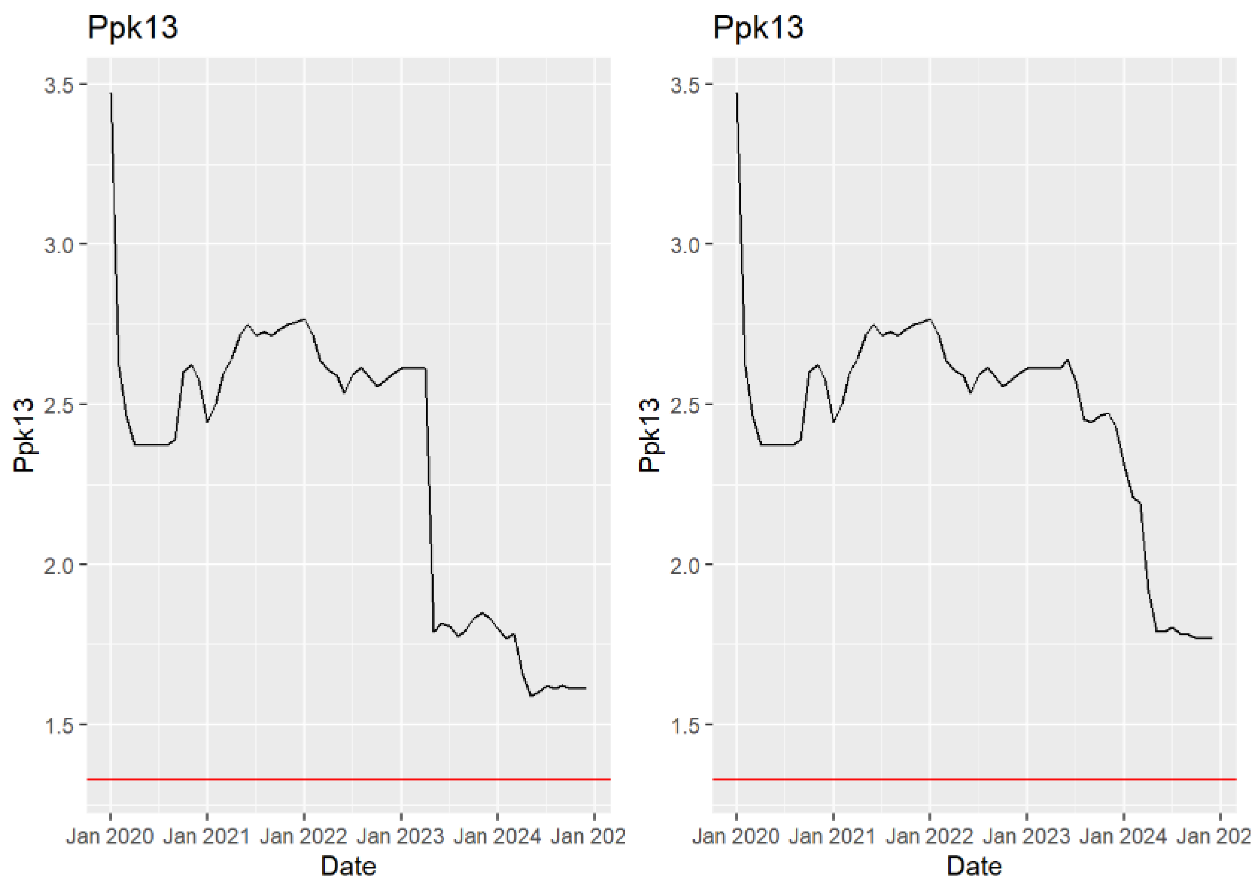


Figure 6: Before/after Ppk graphs showing the influence of extreme observations; trajectory still negative

Based on the analysis, the team finds that 13 of the 44 features (eight on one part and five on the other) are on a good Ppk trajectory. A good trajectory is either trending upward or consistently above the Ppk threshold of 1.33 (Figure 7). Other features are either below 1.33 and not showing signs of improvement or are above 1.33 and showing enough of a downward trajectory to be of concern (Figure 6).

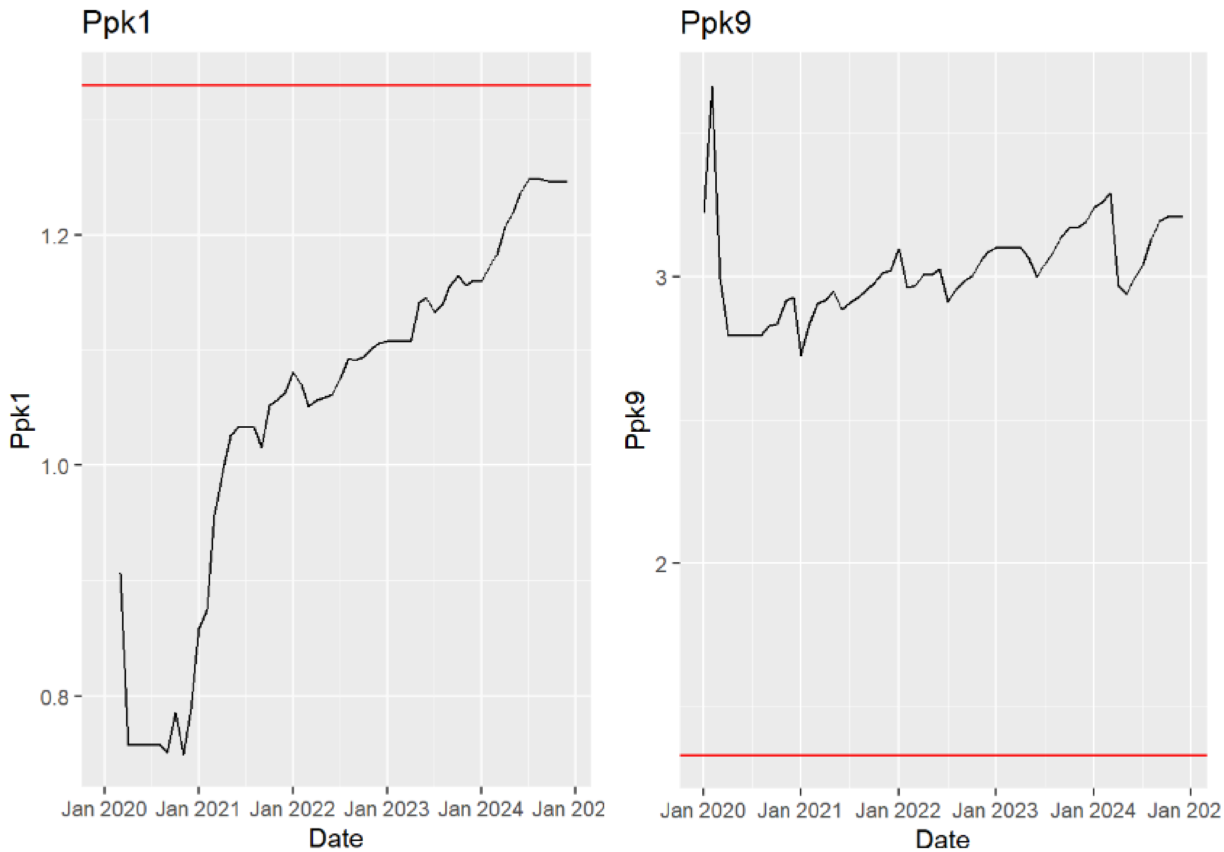


Figure 7: Upwards Ppk trend (left), consistent above 1.33 Ppk (right)

The control charts previously spoken about were affected by this in a few unintended ways. In general, it is expected that a process will not stay the same across the four years; thus, there will be discrepancies when analyzing such a range of time. However, an unexpected recurring issue appeared very consistently across the features (Figure 8). From around early April to early June of 2024, there was a strange shift in the mean value. The processes before and after this period appear to be similar, making this period more unusual.

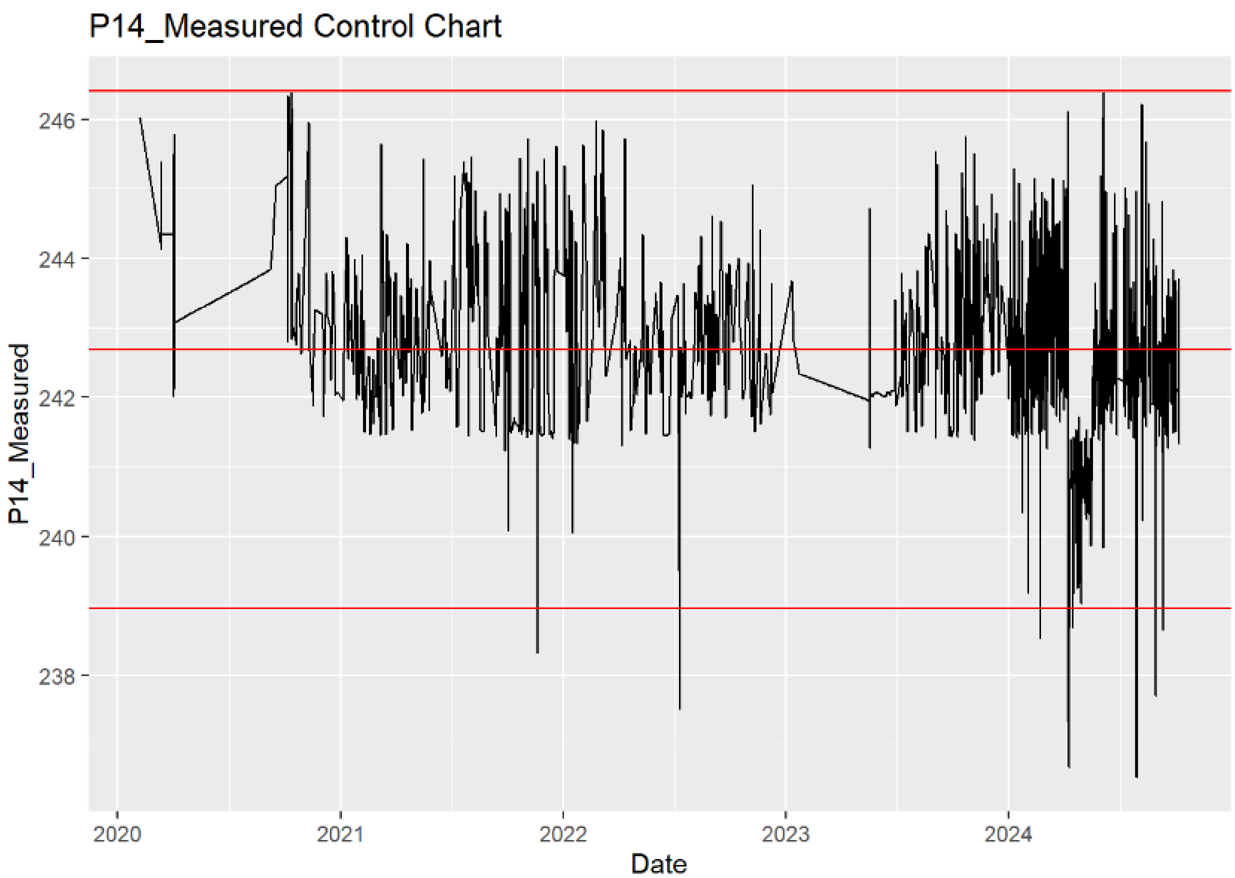


Figure 8: Unusual process change from April-June 2024

While discussions between the team and the engineers at DeeZee could not come to a conclusive answer for this period, it is something to be aware of moving forward in case of a similar occurrence. A process change as significant as that, if not just a measurement error, could be evidence of something problematic.

The results of the Gauge R&R confirmed that one source of measurement variability came from operators' differences. For the four different levels of operator in the study, there were consistent differences in what was measured for each given feature and part. This variation was most noticeable in the brace-to-brace length measurement, feature 21 (Figure 9).

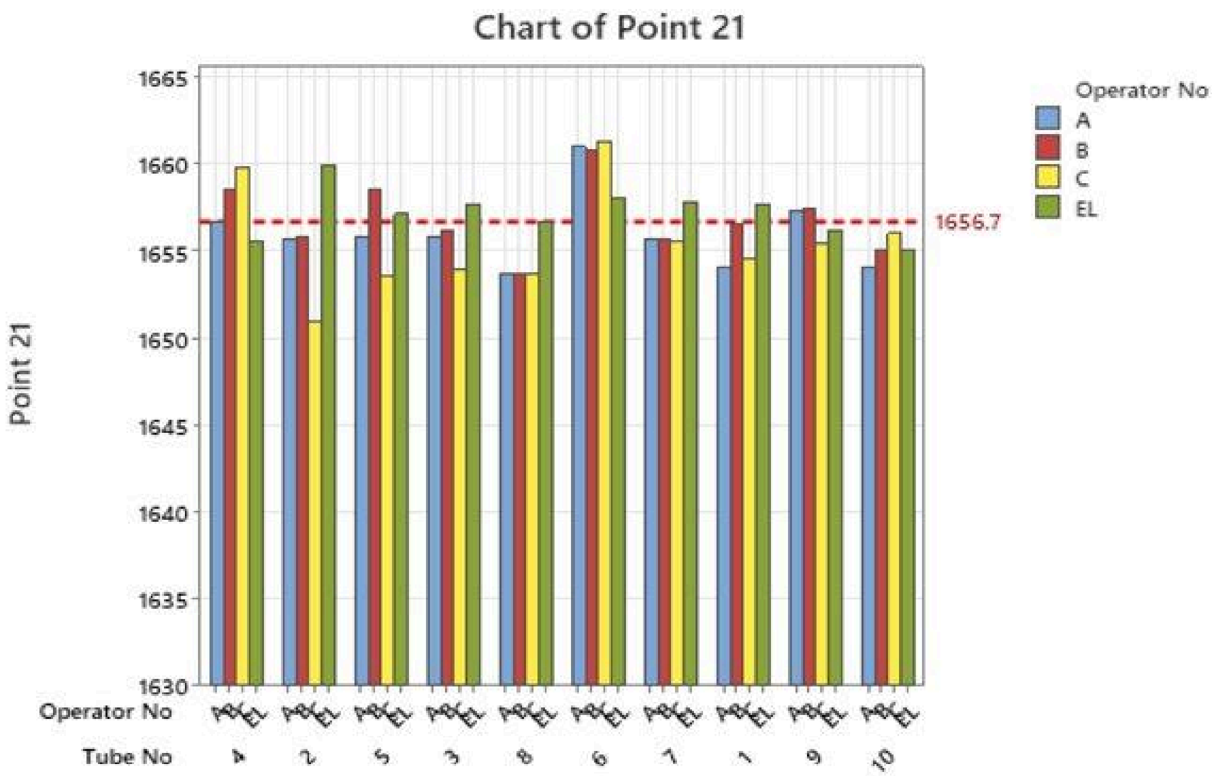


Figure 9: Gauge R&R findings showing variance between operators

The difference between the operators can be seen consistently between parts, with parts seven and eight seeming to be exceptions. One thing that was also noted during the study was that height influenced the operator's ability to load the part onto the station and reach certain features to measure them.

A further study by the engineers at DeeZee found that one operator measuring the same part multiple times yielded minimal variation. Thus, there is evidence that more of the non-random variation in measurement can be attributed to reproducibility between operators than the repeatability for a single operator.

Recommendations/Project Impact

The team observed every aspect of the manufacturing line and measurement process throughout the project. Additionally, DeeZee conducted a Gauge R&R that the team could observe. Given all of the observations and analysis of the data, the team has developed five different recommendations.

Firstly, the data shows that for some points, the mean of the data is skewed from where the process is supposed to be. Upon analysis of the measurement too, it was determined that a recalibration of the measuring fixture was needed. The fixture itself had not been calibrated in 4 years and was due for a recalibration from the manufacturer.

Additionally, during the observation of the Gauge R&R it was clear that accessibility to the loading process was a problem. Often, when a shorter operator would use the laser tool, they would be unable to reach certain parts of the fixture comfortably resulting in a skewed measurement. DeeZee's engineers and the team concluded that lowering the measuring fixture or creating an accessible platform would be ideal for curbing this measurement failure.

Given the complexity of using the tool and the urge for operators to often rush the process, the team recommends familiarizing employees with a standard procedure for loading and measuring the running boards. The need for standardized processes became evident when running the Gauge R&R as operators would have measurements utterly different from the engineers, partially based on how they loaded the parts. Additionally, creating a way to ensure measurement operators take their time with the process is essential.

When observing the laser-cutting process, the team noticed the current method of measuring and verifying hole locations needed to be improved. The hole locations are the basis for all further attachments. Therefore, it is crucial to the manufacturing process that these holes are in the correct location. The current measuring tool consists of a large board constrained to the end of the board and has cutouts where the holes should be. An operator then has to eyeball to analyze the location correctly. The team recommends creating a board similar to that but with large Go/No-Go gauges in the position of the holes. Below is a picture of what this might look like. The sides have handles that hold it to the sides of the running board and act as handles. The pegs in the middle line up to the holes on the board and act as the Go/No-Go gauges.

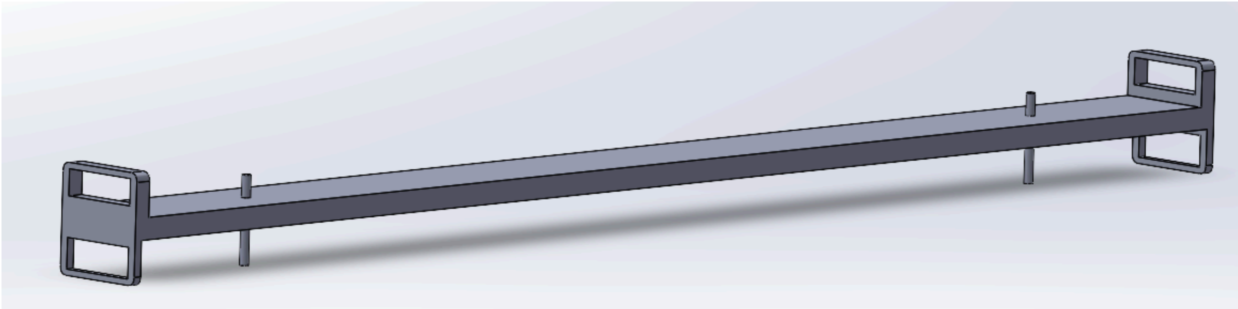


Figure 10: Concept image of proposed Go/No-Go board

Finally, the main issue that the team wanted to solve for the DeeZee engineers was how to approach historical data. DeeZee had a system to obtain large amounts of historical data for the studied parts. However, the engineers needed clarification about what to do with the data or where to go with all the data. The team created RStudio code to review all the data and generate Ppk graphs and other statistical data for the engineering team. DeeZee has to form Ppk graphs and analyses for all the parts they create for Ford. Using this software, they can create Ppk graphs similar to the ones the team formed for these two parts, assisting them with meeting with Ford in March 2025.

Assumptions and Limitations

While this project gives good insight into the historical data regarding the Ppk of the Ford Running Boards data analysis, one of the main assumptions for this project is that Ford is requesting historical analyses and not month-by-month analyses. One issue with doing Ppk analyses over time is that the process could have changed over the four years. The team does recognize this, and recommends that the employees at DeeZee look into doing month-by-month analyses of parts of the process with low Ppk values. There is a likelihood that the process was not stable during these months when the Ppk values dipped low. It is a good idea to look into these months of data and see if the process was stable or if these months are where the most amount of anomalous data came from.

Another central area for improvement the team encountered was the timing of data analysis and experiments. Due to how the teams' schedules worked out, the team could usually only go to the DeeZee plant to collect data during the morning shift. While the team recognized that the primary source of variability was reproducibility between operators, another factor considered was variability between shifts. DeeZee runs its operations 24/7 and analyzes the data taken from all three shifts. Since the team could not run a Gauge R&R for these other shifts, one idea that could be considered and studied further is variation between shifts.

A significant assumption given by the DeeZee engineers was that specific part measurements would be anomalous or stated as “impossible” by the engineers. Usually, when a part was deemed faulty via a measurement, it would only have up to a few points on the part where it would fall out of specifications. Additionally, this part would usually only fall about one or two millimeters out of specification above or below the standard specifications. When analyzing the data, the DeeZee engineers requested that the team look into the data and determine which parts were mismeasurements due to a loading error. The team determined these parts would be mismeasurements if ten or more points were out of control limits. Additionally, these parts would usually not be a single millimeter out of control but five or more millimeters out of control. The team acknowledged that this likely was due to a loading or measurement error. However, there is a slight possibility that these data points would not have been misrepresented measurements. Due to these factors, the team decided to assume that those parts would be outliers and removed them from the data set. However, further analyses may wish to include these data points for additional testing.

Acknowledgments

The team would like to thank Nick Swift for introducing the team to the DeeZee engineering team and explaining the project's overall idea. The team would also like to thank Laurie Murphy for working on the project closely with the team and providing MSA and Gauge R&R data for the team to analyze. Additionally, the team would like to thank Eric Jones for working closely with Laurie and helping determine what DeeZee is looking for in anticipation of their meeting with Ford. The team would also like to thank Ryan Peltier and Andrew Theobald for working closely with the team and providing valuable insights. Lastly, the team would like to thank the DeeZee operators and workers who assisted with data collection.

Appendices

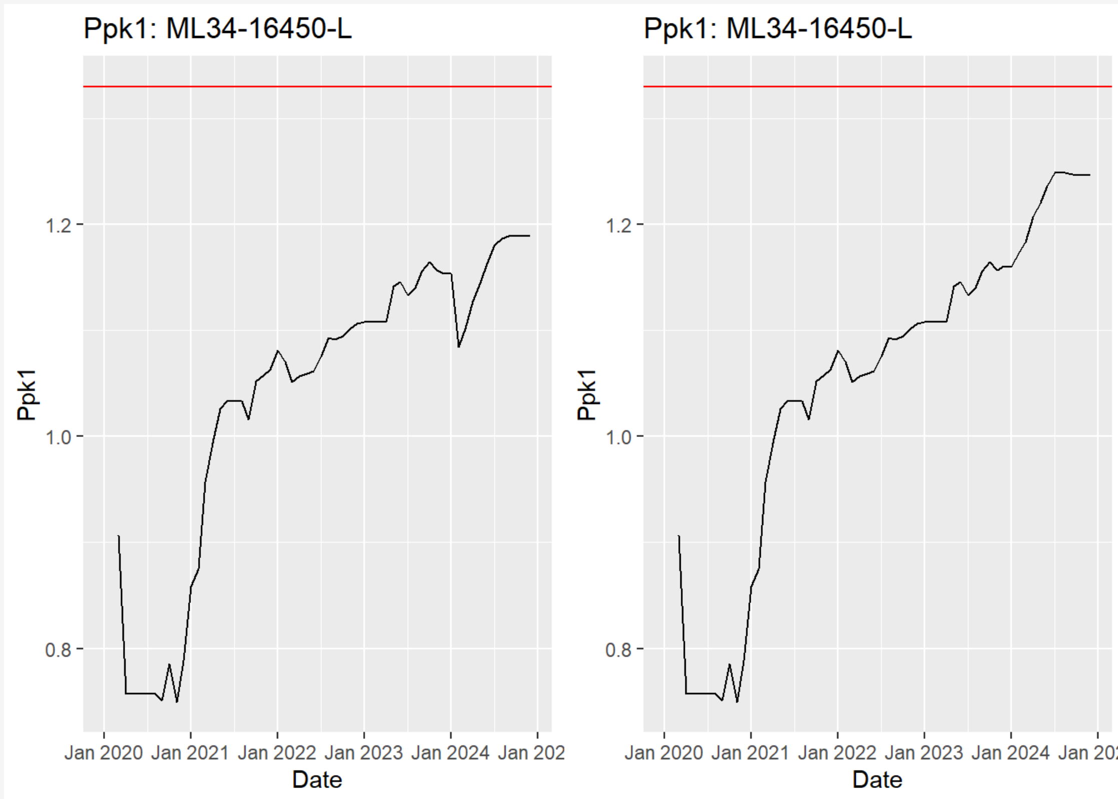
ML34-16450-L Output Data from DeeZee's Statistical Software

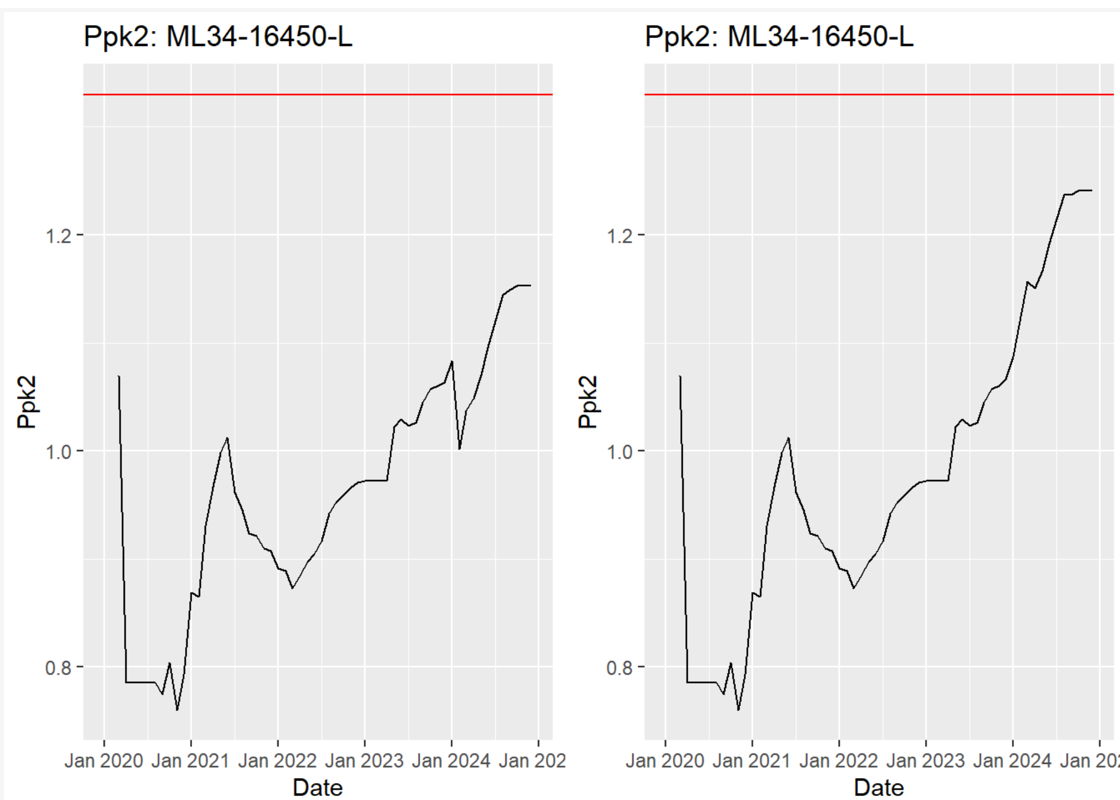
Labels		Feature 1	Feature 2	Feature 3	Feature 4	Feature 5	Feature 6	Feature 7	Feature 8	Feature 9	Feature 10	Feature 11	Feature 12	Feature 13	Feature 14	Feature 15	Feature 16	Feature 17	Feature 18	Feature 19	Feature 20	Feature 21	Feature 22
Ppk		1.189	1.153	1.934	1.472	1.821	2.769	1.940	1.225	2.533	2.682	1.217	2.252	1.640	0.989	1.038	1.485	0.845	1.444	1.099	0.733	0.852	1.458
	USL	-94.500	-94.500	-106.000	-101.400	-113.100	-105.100	-106.000	246.500	-109.100	-110.000	246.500	-105.100	-106.000	246.500	-102.400	-113.100	-94.500	-106.000	-94.500	300.600	1514.700	2214.200
Specificati	Nominal	-98.500	-98.500	-110.000	-105.400	-117.100	-109.100	-110.000	241.500	-113.100	-114.000	241.500	-109.100	-110.000	241.500	-106.400	-117.100	-98.500	-110.000	-98.500	298.100	1512.200	2209.200
	LSL	-102.500	-102.500	-114.000	-109.400	-121.100	-113.100	-114.000	236.500	-117.100	-118.000	236.500	-113.100	-114.000	236.500	-110.400	-121.100	-102.500	-114.000	-102.500	292.100	1509.700	2201.200
	Data Points	1885	1885	1885	1885	1885	1884	1885	1885	1884	1885	1885	1884	1884	1883	1883	1863	1863	1885	1885	1885	1885	1886
Summary !	Maximum	-94.690	-94.675	-106.839	-102.921	-113.757	-106.369	-107.046	246.178	-110.912	-111.264	246.321	-105.667	-106.231	246.389	-102.805	-113.250	-94.226	-106.200	-93.873	304.493	1516.559	2213.945
	Mean	-98.333	-97.738	-109.740	-105.784	-116.707	-108.870	-109.664	242.333	-113.404	-114.009	242.603	-109.087	-109.753	242.680	-105.674	-116.797	-97.593	-109.669	-98.641	298.114	1512.198	2209.285
	Minimum	-112.170	-112.215	-123.859	-120.091	-130.977	-122.859	-123.886	227.758	-127.072	-128.004	227.791	-123.087	-123.971	227.639	-120.475	-131.100	-112.526	-124.000	-112.533	284.413	1507.420	2195.425
	Sigma (σ_s)	1.075	0.936	0.645	0.819	0.660	0.454	0.630	1.134	0.486	0.496	1.067	0.590	0.763	1.287	1.052	0.830	1.220	0.847	1.170	1.130	0.978	1.124
	Avg. Range	0.874	0.624	0.457	0.578	0.428	#VALUE!	0.411	0.644	0.226	0.318	0.592	0.468	0.577	0.868	0.811	0.613	0.880	0.649	1.047	0.847	0.881	0.830
Subgroup	d_2	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128
	Estimated Sigma ($\sigma_{R/}$	0.774	0.553	0.405	0.512	0.379	#VALUE!	0.365	0.571	0.201	0.282	0.525	0.415	0.512	0.770	0.719	0.544	0.780	0.575	0.928	0.751	0.781	0.735
	E_2	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660
	UCL_x	-96.009	-96.079	-108.525	-104.247	-115.570	#VALUE!	-108.570	244.047	-112.802	-113.164	244.178	-107.843	-108.218	244.989	-103.518	-115.166	-95.252	-107.944	-95.855	300.367	1514.542	2211.492
	LCL_x	-100.657	-99.396	-110.955	-107.322	-117.845	#VALUE!	-110.759	240.620	-114.006	-114.854	241.027	-110.332	-111.288	240.371	-107.831	-118.429	-99.934	-111.394	-101.426	295.861	1509.854	2207.079
	D_4	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267
	UCL_{mR}	2.854	2.037	1.492	1.888	1.397	#VALUE!	1.344	2.104	0.739	1.038	1.935	1.529	1.885	2.836	2.648	2.004	2.875	2.119	3.421	2.767	2.879	2.710
	Pp	1.240	1.425	2.068	1.628	2.019	2.938	2.118	1.470	2.741	2.688	1.561	2.260	1.747	1.295	1.268	1.606	1.093	1.574	1.139	1.254	0.852	1.928
Process In	Pr	0.806	0.702	0.484	0.614	0.495	0.340	0.472	0.680	0.365	0.372	0.640	0.443	0.572	0.772	0.789	0.623	0.915	0.635	0.878	0.798	1.173	0.519
	PPU	1.189	1.153	1.934	1.784	1.821	2.769	1.940	1.225	2.950	2.694	1.217	2.252	1.640	0.989	1.038	1.485	0.845	1.444	1.180	0.733	0.853	1.458
	PPL	1.292	1.696	2.202	1.472	2.217	3.106	2.296	1.715	2.533	2.682	1.906	2.267	1.855	1.600	1.498	1.728	1.341	1.704	1.099	1.774	0.852	2.399
	Ppk	1.189	1.153	1.934	1.472	1.821	2.769	1.940	1.225	2.533	2.682	1.217	2.252	1.640	0.989	1.038	1.485	0.845	1.444	1.099	0.733	0.852	1.458
	Cp	1.722	2.412	3.292	2.603	3.517	#VALUE!	3.655	2.919	6.646	4.734	3.174	3.214	2.607	2.166	1.856	2.452	1.709	2.319	1.436	1.887	1.067	2.946
Capability	Cr	0.581	0.415	0.304	0.384	0.284	#VALUE!	0.274	0.343	0.150	0.211	0.315	0.311	0.384	0.462	0.539	0.408	0.585	0.431	0.696	0.530	0.937	0.339
	CPU	1.650	1.952	3.078	2.853	3.172	#VALUE!	3.348	2.432	7.151	4.745	2.474	3.204	2.446	1.655	1.519	2.267	1.321	2.127	1.487	1.103	1.067	2.228
	CPL	1.794	2.871	3.506	2.353	3.863	#VALUE!	3.962	3.405	6.140	4.723	3.873	3.224	2.767	2.677	2.192	2.637	2.096	2.511	1.386	2.670	1.066	3.665
	Cpk	1.650	1.952	3.078	2.353	3.172	#VALUE!	3.348	2.432	6.140	4.723	2.474	3.204	2.446	1.655	1.519	2.267	1.321	2.127	1.386	1.103	1.066	2.228
	Count Above	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	11	15	0
Out of Spe	Above %	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.054%	0.000%	0.053%	0.584%	0.796%	0.000%
	Count Below	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	2	2	2	1	1	2	1
	Below %	0.053%	0.053%	0.053%	0.106%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.106%	0.053%	0.053%	0.107%	0.107%	0.106%	0.053%	0.053%	0.106%	0.053%
	Total %	0.053%	0.053%	0.053%	0.106%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.053%	0.106%	0.053%	0.053%	0.107%	0.161%	0.106%	0.106%	0.637%	0.902%	0.053%
	Z_{USL}	4.949	5.856	9.235	8.558	9.515	#VALUE!	10.044	7.296	21.453	14.234	7.421	9.612	7.337	4.964	4.557	6.800	3.964	6.381	4.460	3.310	3.202	6.683
Theoretica	Pz_{USL}	1.000	1.000	1.000	1.000	1.000	#VALUE!	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000
	Above %	0.000%	0.000%	0.000%	0.000%	0.000%	#VALUE!	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.004%	0.000%	0.000%	0.047%	0.068%	0.000%
	Z_{LSL}	5.381	8.614	10.518	7.058	11.588	#VALUE!	11.886	10.215	18.420	14.170	11.620	9.673	8.302	8.031	6.576	7.912	6.289	7.533	4.157	8.010	3.198	10.994
	Pz_{LSL}	1.000	1.000	1.000	1.000	1.000	#VALUE!	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000
	Below %	0.000%	0.000%	0.000%	0.000%	0.000%	#VALUE!	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.002%	0.000%	0.069%	0.000%
	Total %	0.000%	0.000%	0.000%	0.000%	0.000%	#VALUE!	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.004%	0.000%	0.002%	0.047%	0.137%	0.000%
	3 Sigma	-96.010	-96.079	-108.525	-104.247	-115.570	#VALUE!	-108.570	244.046	-112.802	-113.164	244.178	-107.843	-108.219	244.989	-103.519	-115.166	-95.252	-107.944	-95.856	300.367	1514.542	2211.492
3 Sigma Lir	-3 Sigma	-100.656	-99.396	-110.955	-107.321	-117.844	#VALUE!	-110.759	240.620	-114.006	-114.854	241.027	-110.332	-111.288	240.372	-107.830	-118.429	-99.934	-111.394	-101.426	295.862	1509.855	2207.079

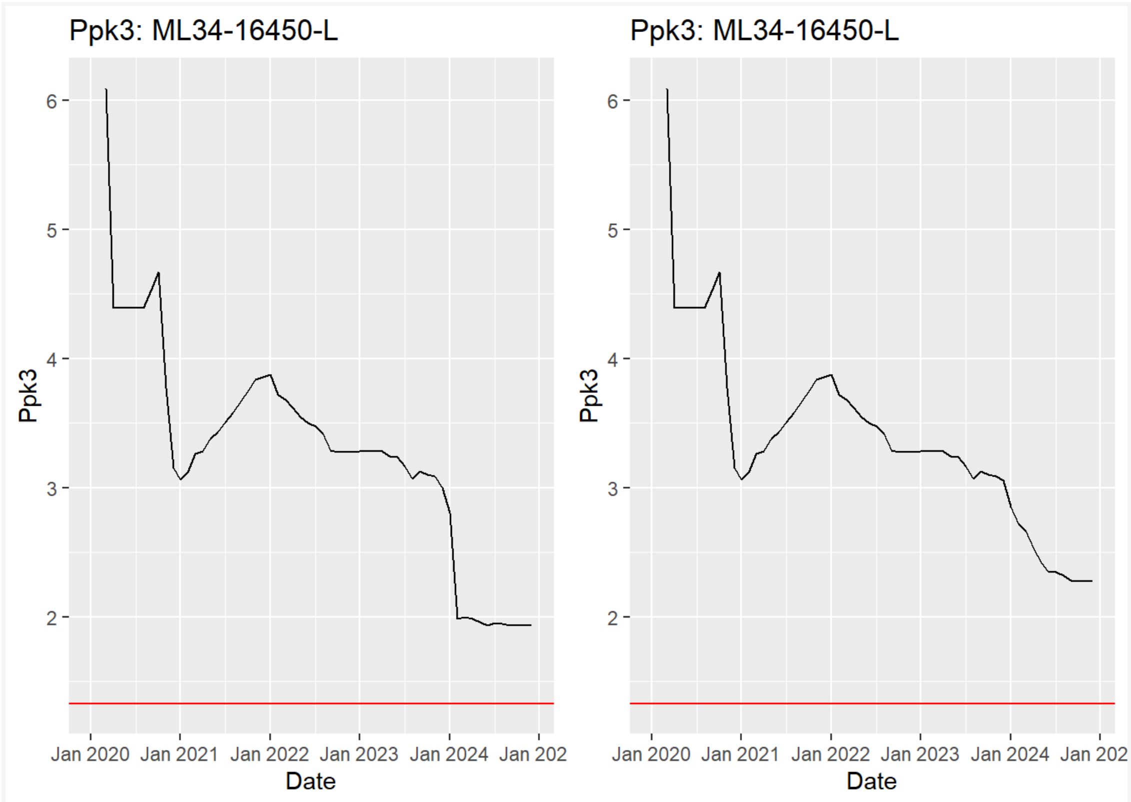
ML34-16451-L Output Data from DeeZee's Statistical Software

Labels		Feature 1	Feature 2	Feature 3	Feature 4	Feature 5	Feature 6	Feature 7	Feature 8	Feature 9	Feature 10	Feature 11	Feature 12	Feature 13	Feature 14	Feature 15	Feature 16	Feature 17	Feature 18	Feature 19	Feature 20	Feature 21	Feature 22
Ppk		0.739	0.590	1.996	0.383	1.940	2.580	2.092	0.668	2.597	2.906	0.773	1.831	1.614	0.823	0.704	1.482	0.666	1.333	1.049	0.696	0.589	1.297
	USL	-94.500	-94.500	-106.000	-102.400	-113.100	-105.100	-106.000	246.500	-109.100	-110.000	246.500	-105.100	-106.000	246.500	-102.400	-113.100	-94.500	-106.000	-94.500	228.380	1659.210	2214.240
Specificati	Nominal	-98.500	-98.500	-110.000	-106.400	-117.100	-109.100	-110.000	241.500	-113.100	-114.000	241.500	-109.100	-110.000	241.500	-106.400	-117.100	-98.500	-110.000	-98.500	224.130	1656.710	2207.740
	LSL	-102.500	-102.500	-114.000	-110.400	-121.100	-113.100	-114.000	236.500	-117.100	-118.000	236.500	-113.100	-114.000	236.500	-110.400	-121.100	-102.500	-114.000	-102.500	219.880	1654.210	2201.240
	Data Points	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204	2204
Summary !	Maximum	-94.106	-93.614	-106.005	-106.005	-113.648	-106.423	-106.432	246.942	-111.516	-112.318	246.042	-106.888	-107.287	247.026	-102.475	-114.271	-94.102	-106.647	-94.547	233.378	1662.880	2214.223
	Mean	-97.454	-96.993	-109.692	-109.692	-116.682	-108.788	-109.610	243.002	-113.258	-113.953	243.077	-108.707	-109.608	243.073	-105.124	-116.659	-97.158	-109.528	-98.014	225.868	1656.994	2208.949
	Minimum	-112.243	-112.260	-123.702	-123.702	-130.834	-122.859	-123.747	228.202	-126.824	-127.711	227.616	-123.055	-123.979	227.966	-120.356	-131.051	-112.394	-123.909	-112.375	215.572	1642.929	2195.675
	Sigma (σ_s)	1.332	1.408	0.617	0.617	0.616	0.477	0.575	1.745	0.493	0.453	1.476	0.657	0.745	1.387	1.289	0.800	1.330	0.882	1.116	1.203	1.253	1.360
	Avg. Range	1.058	0.850	0.453	0.453	0.401	0.317	0.380	1.090	0.248	0.292	0.771	0.429	0.516	0.830	0.759	0.541	0.801	0.584	0.949	1.099	1.097	1.177
Subgroup	d_2	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128	1.128
	Estimated Sigma ($\sigma_{R/}$	0.938	0.753	0.402	0.402	0.355	0.281	0.337	0.966	0.219	0.259	0.683	0.380	0.457	0.736	0.673	0.480	0.710	0.518	0.842	0.975	0.973	1.043
	E_2	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660	2.660
	UCL_x	-94.639	-94.734	-108.486	-108.486	-115.616	-107.945	-108.599	245.901	-112.600	-113.175	245.127	-107.565	-108.236	245.281	-103.104	-115.219	-95.027	-107.975	-95.488	228.792	1659.913	2212.080
	LCL_x	-100.268	-99.253	-110.898	-110.898	-117.748	-109.632	-110.620	240.103	-113.916	-114.731	241.027	-109.848	-110.980	240.865	-107.143	-118.099	-99.288	-111.082	-100.540	222.943	1654.076	2205.818
	D_4	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267	3.267
	UCL_{mR}	3.457	2.775	1.481	1.481	1.309	1.036	1.241	3.560	0.809	0.955	2.518	1.402	1.685	2.712	2.481	1.768	2.617	1.908	3.102	3.592	3.585	3.845
	Pp	1.001	0.947	2.162	2.162	2.166	2.798	2.318	0.955	2.704	2.940	1.129	2.031	1.789	1.201	1.034	1.666	1.002	1.512	1.194	1.177	0.665	1.593
Process In	Pr	0.999	1.056	0.463	0.463	0.462	0.357	0.431	1.047	0.370	0.340	0.886	0.492	0.559	0.832	0.967	0.600	0.998	0.662	0.837	0.849	1.504	0.628
	PPU	0.739	0.590	1.996	3.942	1.940	2.580	2.092	0.668	2.810	2.906	0.773	1.831	1.614	0.823	0.704	1.482	0.666	1.333	1.049	0.696	0.589	1.297
	PPL	1.263	1.304	2.329	0.383	2.392	3.016	2.544	1.242	2.597	2.975	1.485	2.230	1.964	1.579	1.364	1.849	1.339	1.690	1.339	1.659	0.741	1.889
	Ppk	0.739	0.590	1.996	0.383	1.940	2.580	2.092	0.668	2.597	2.906	0.773	1.831	1.614	0.823	0.704	1.482	0.666	1.333	1.049	0.696	0.589	1.297
	Cp	1.421	1.770	3.318	3.318	3.754	4.743	3.959	1.725	6.076	5.143	2.439	3.504	2.916	2.265	1.981	2.779	1.878	2.576	1.584	1.453	0.857	2.076
Capability	Cr	0.704	0.565	0.301	0.301	0.266	0.211	0.253	0.580	0.165	0.194	0.410	0.285	0.343	0.442	0.505	0.360	0.533	0.388	0.631	0.688	1.167	0.482
	CPU	1.050	1.104	3.062	6.048	3.362	4.374	3.573	1.207	6.316	5.082	1.670	3.160	2.630	1.552	1.349	2.472	1.248	2.272	1.392	0.859	0.759	1.690
	CPL	1.793	2.437	3.573	0.587	4.146	5.113	4.345	2.243	5.836	5.203	3.209	3.849	3.202	2.977	2.613	3.085	2.508	2.879	1.776	2.048	0.954	2.463
	Cpk	1.050	1.104	3.062	0.587	3.362	4.374	3.573	1.207	5.836	5.082	1.670	3.160	2.630	1.552	1.349	2.472	1.248	2.272	1.392	0.859	0.759	1.690
	Count Above	2	1	0	0	0	0	0	1	0	0	0	0	0	4	0	0	1	0	0	15	30	0
Out of Spe	Above %	0.091%	0.045%	0.000%	0.000%	0.000%	0.000%	0.000%	0.045%	0.000%	0.000%	0.000%	0.000%	0.000%	0.181%	0.000%	0.000%	0.045%	0.000%	0.000%	0.681%	1.361%	0.000%
	Count Below	2	1	1	158	1	1	1	3	1	1	1	1	1	1	1	1	1	1	2	1	16	2
	Below %	0.091%	0.045%	0.045%	7.169%	0.045%	0.045%	0.045%	0.136%	0.045%	0.045%	0.045%	0.045%	0.045%	0.045%	0.045%	0.045%	0.045%	0.045%	0.091%	0.045%	0.726%	0.091%
	Total %	0.181%	0.091%	0.045%	7.169%	0.045%	0.045%	0.045%	0.181%	0.045%	0.045%	0.045%	0.045%	0.045%	0.227%	0.045%	0.045%	0.091%	0.045%	0.091%	0.726%	2.087%	0.091%
	Z_{USL}	3.149	3.311	9.186	18.144	10.085	13.121	10.719	3.621	18.947	15.247	5.010	9.480	7.890	4.657	4.046	7.416	3.743	6.816	4.175	2.578	2.278	5.071
Theoretica	Pz_{USL}	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995	0.989	1.000
	Above %	0.082%	0.047%	0.000%	0.000%	0.000%	0.000%	0.000%	0.015%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.003%	0.000%	0.009%	0.000%	0.001%	0.497%	1.138%	0.000%
	Z_{LSL}	5.379	7.312	10.720	1.762	12.437	15.339	13.035	6.730	17.507	15.609	9.626	11.547	9.605	8.931	7.838	9.256	7.524	8.638	5.329	6.143	2.863	7.388
	Pz_{LSL}	1.000	1.000	1.000	0.961	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	1.000
	Below %	0.000%	0.000%	0.000%	3.903%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.210%	0.000%
	Total %	0.082%	0.047%	0.000%	3.903%	0.000%	0.000%	0.000%	0.015%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.003%	0.000%	0.009%	0.000%	0.001%	0.497%	1.348%	0.000%
	3 Sigma	-94.640	-94.734	-108.486	-108.486	-115.617	-107.945	-108.600	245.900	-112.600	-113.175	245.127	-107.566	-108.236	245.280	-103.104	-115.219	-95.027	-107.975	-95.489	228.792	1659.913	2212.079
3 Sigma Lir	-3 Sigma	-100.268	-99.253	-110.898	-110.898	-117.748	-109.631	-110.620	240.104	-113.916	-114.731	241.027	-109.848	-110.980	240.865	-107.143	-118.098	-99.288	-111.081	-100.539	222.944	1654.076	2205.818

All 44 (22 features x 2 parts) Ppk graphs before and after removing extreme values



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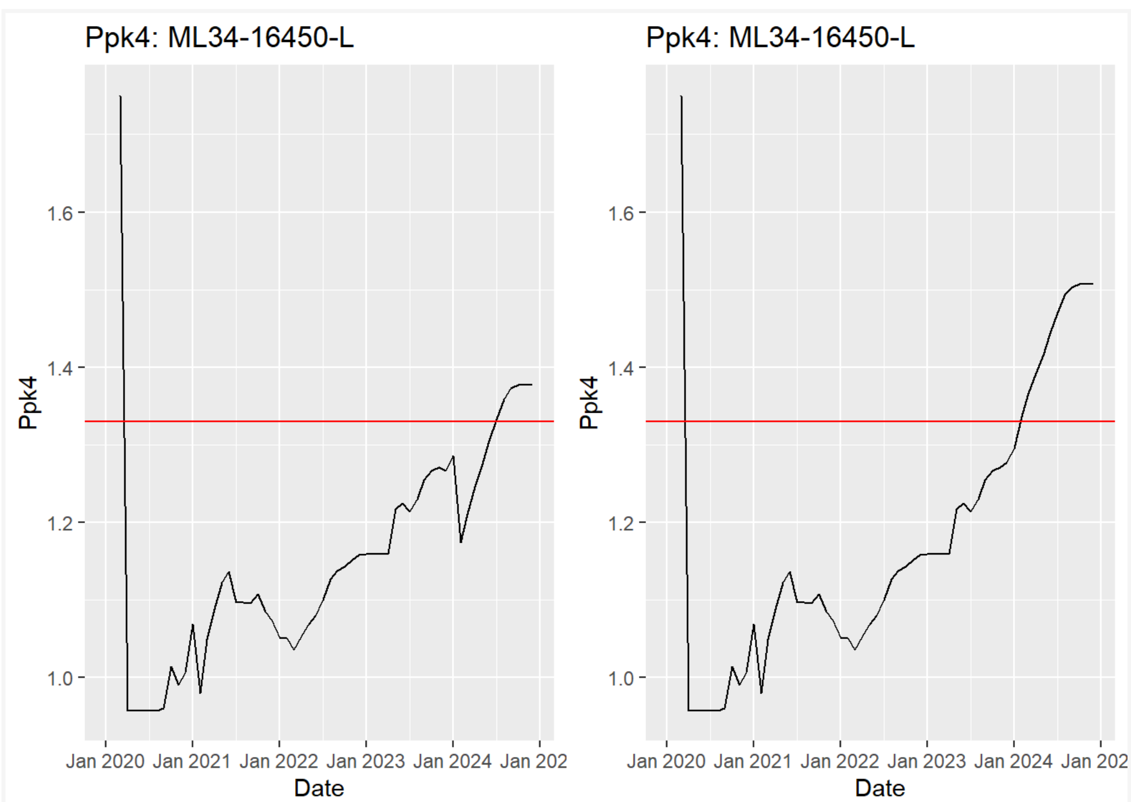
Date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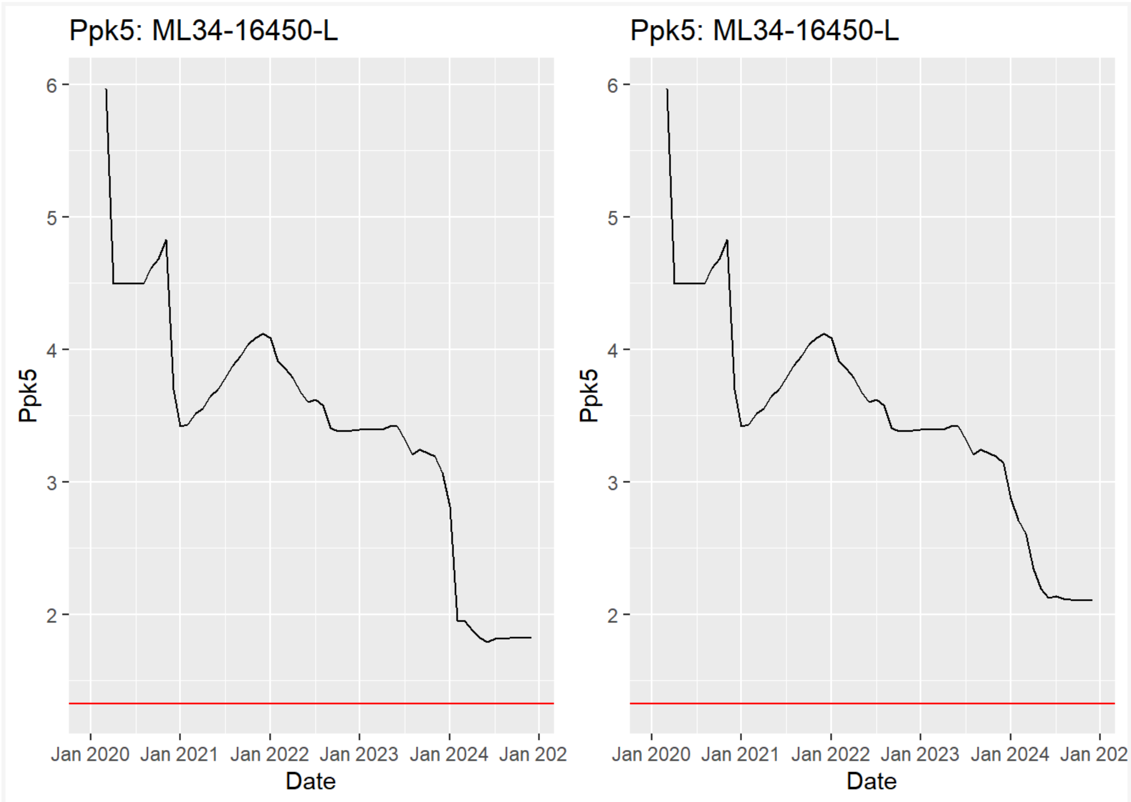
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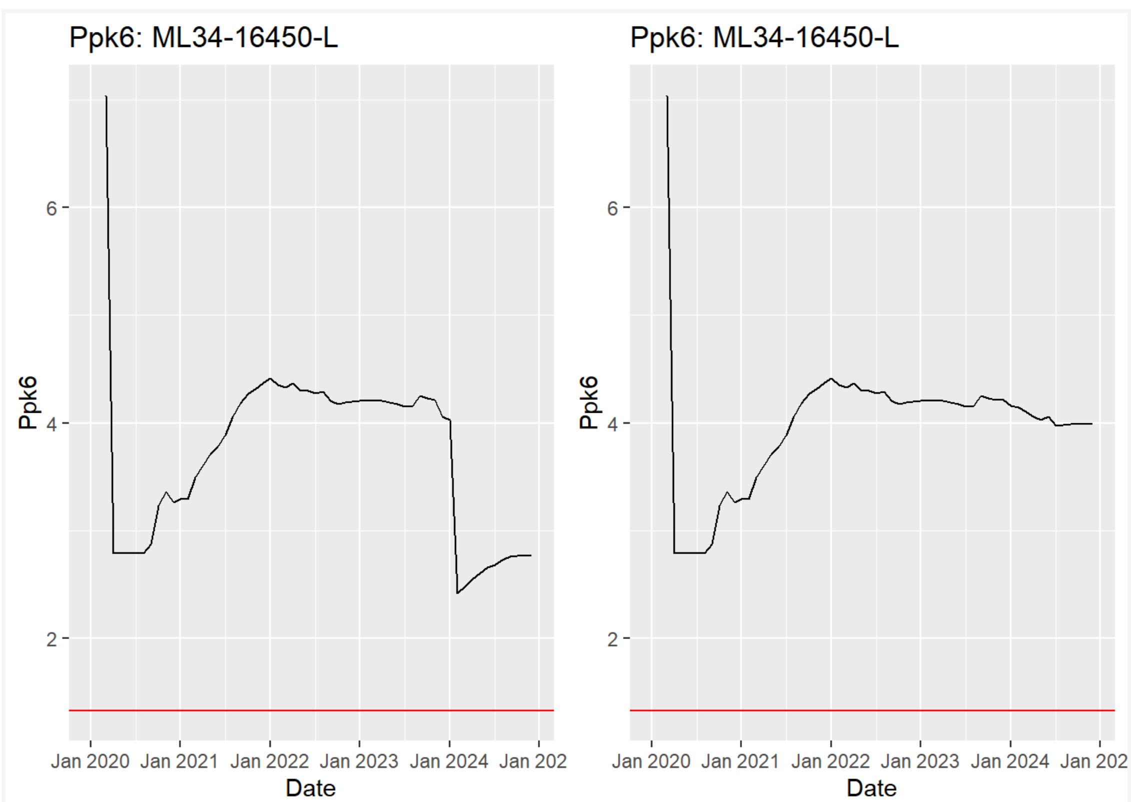
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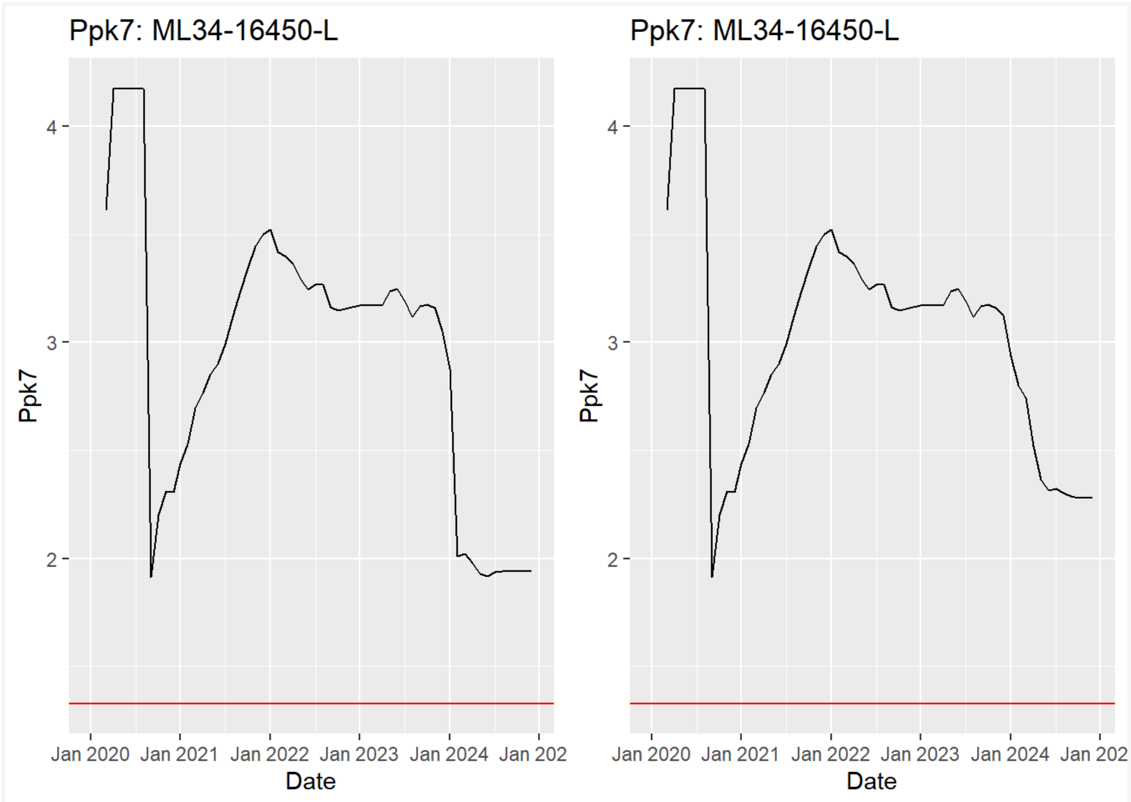
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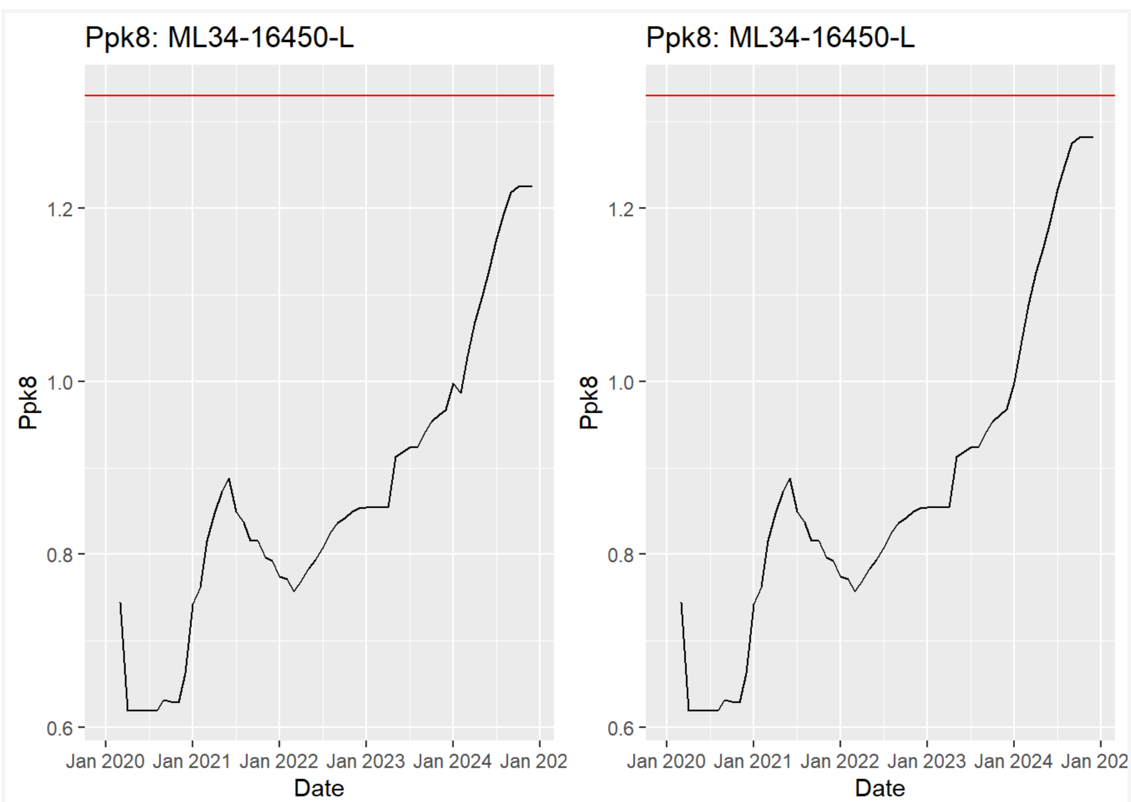
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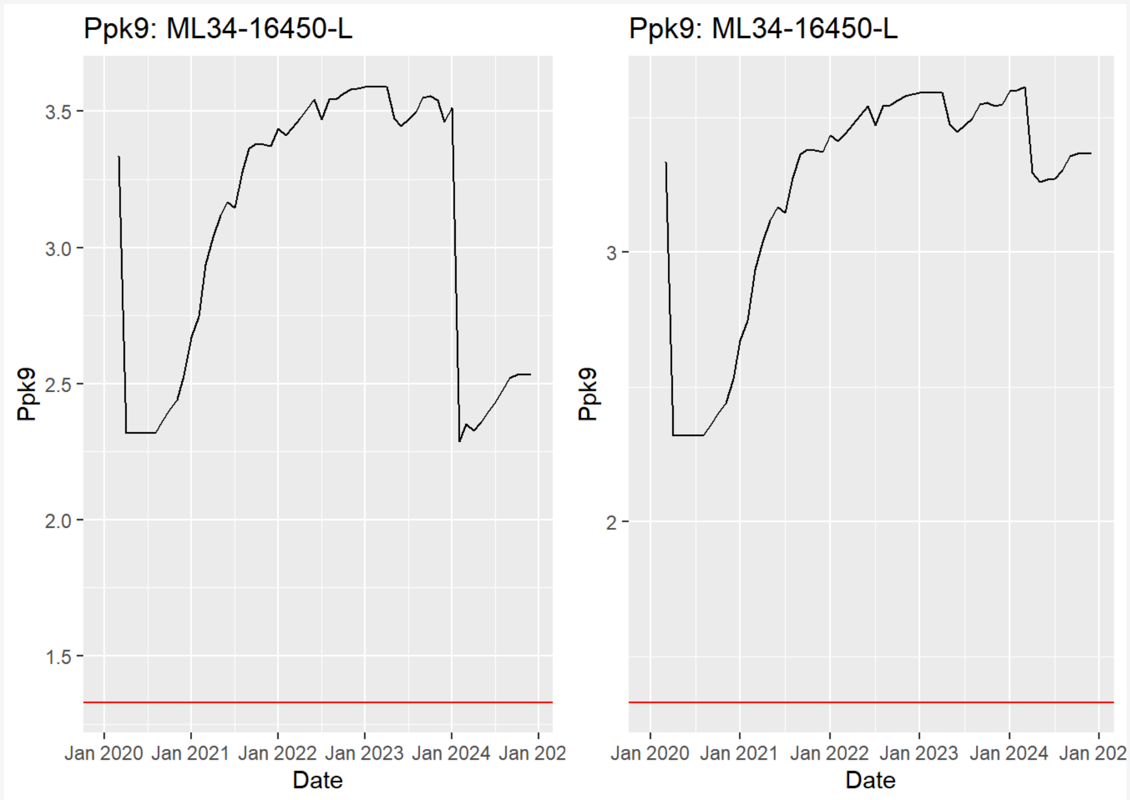
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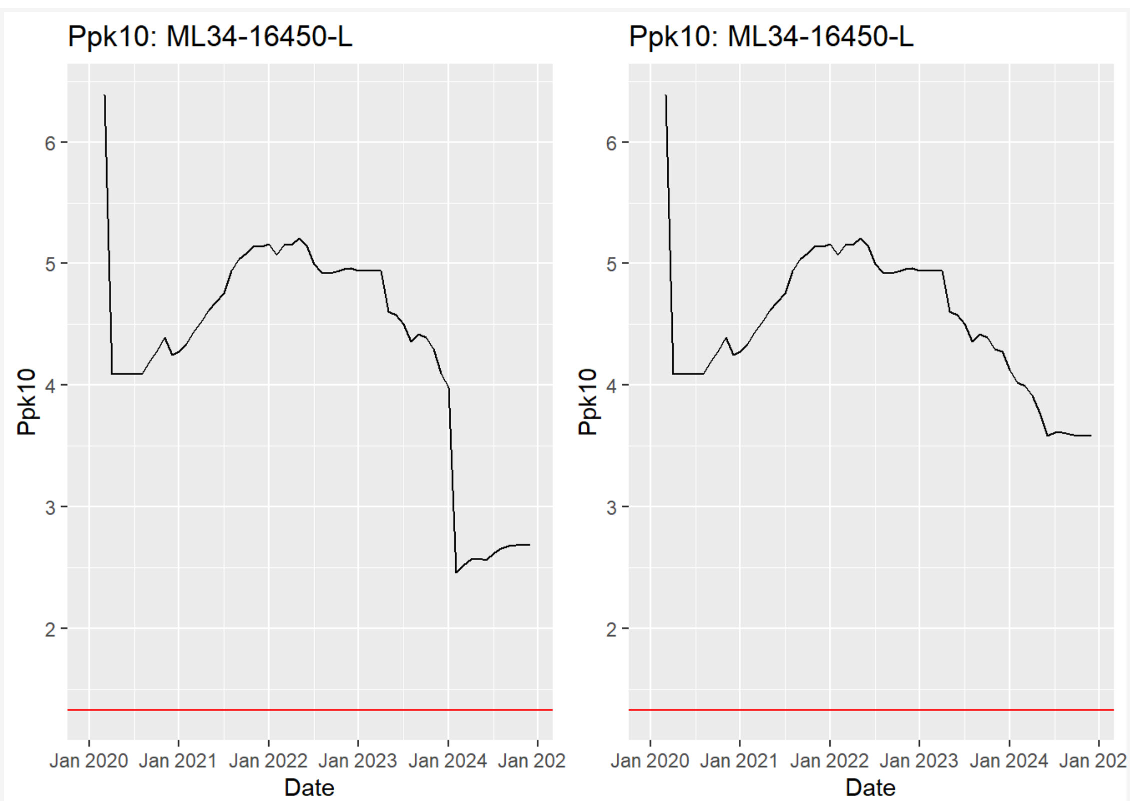
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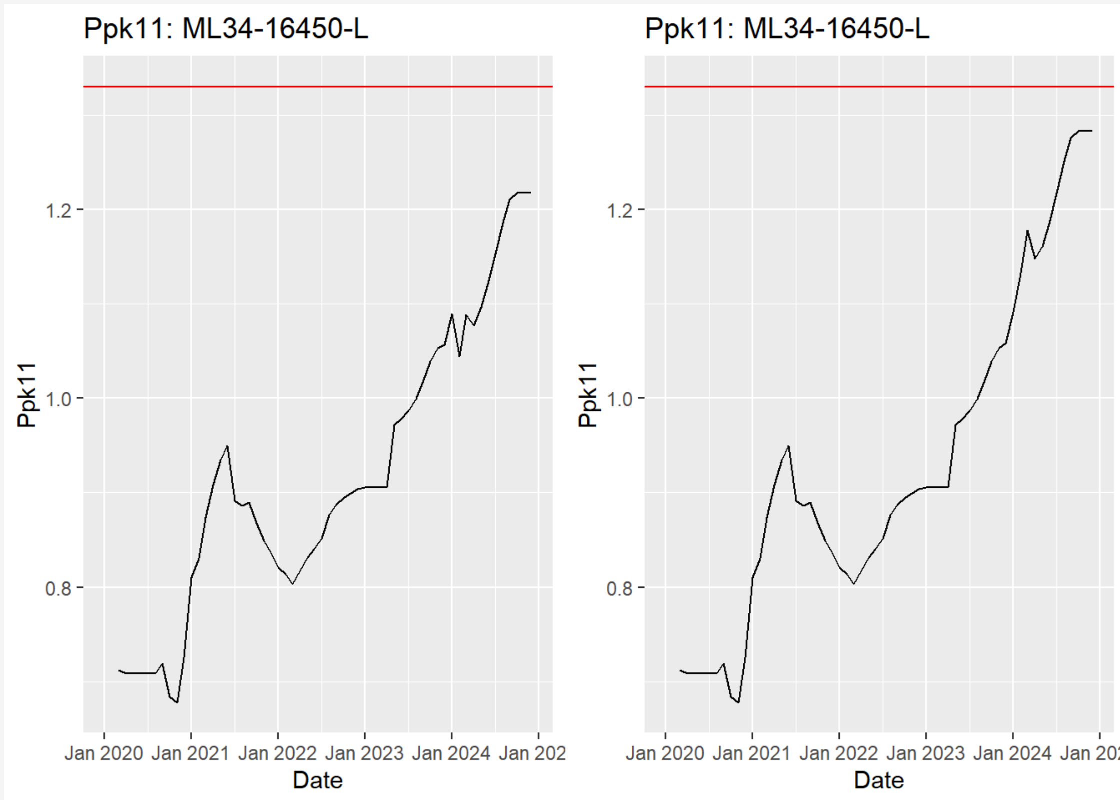
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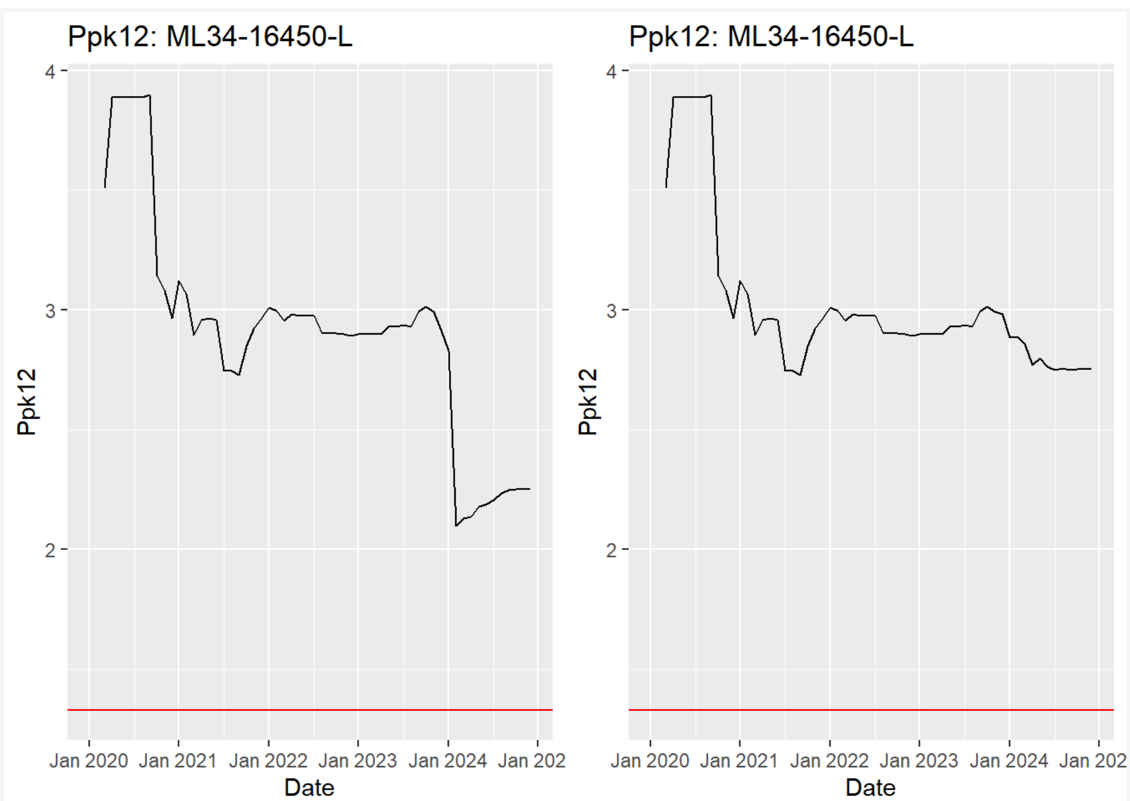
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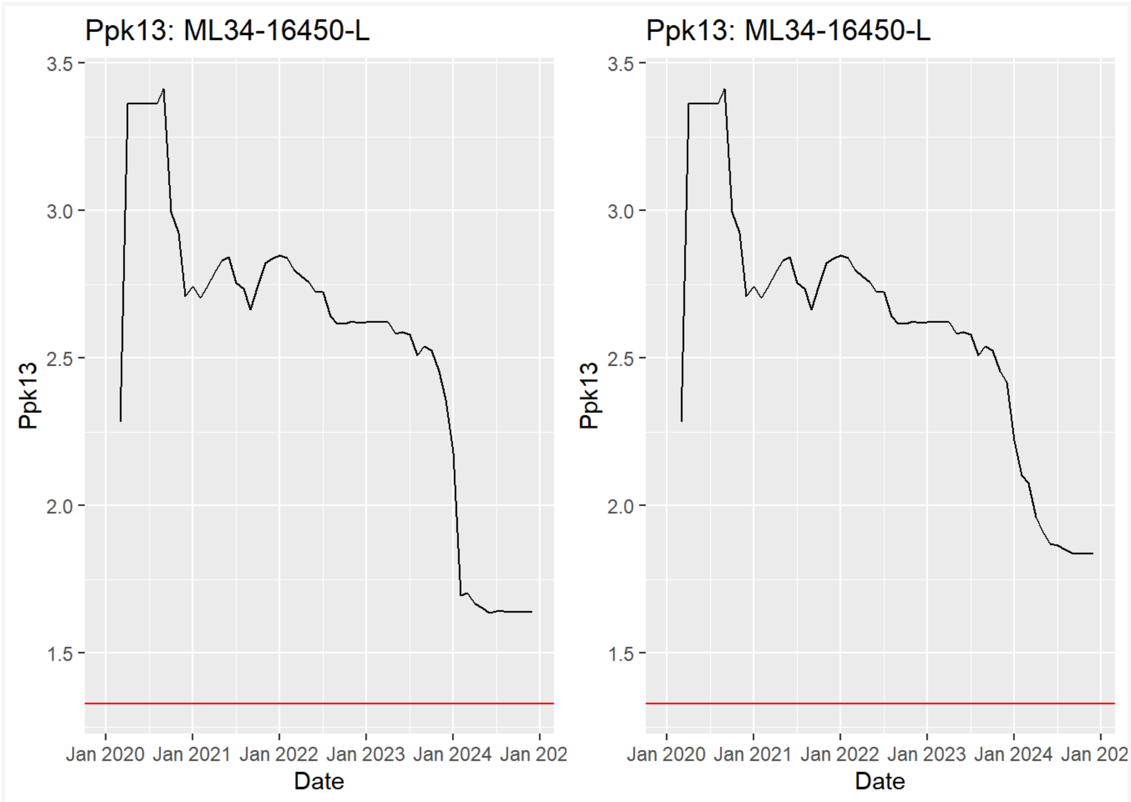
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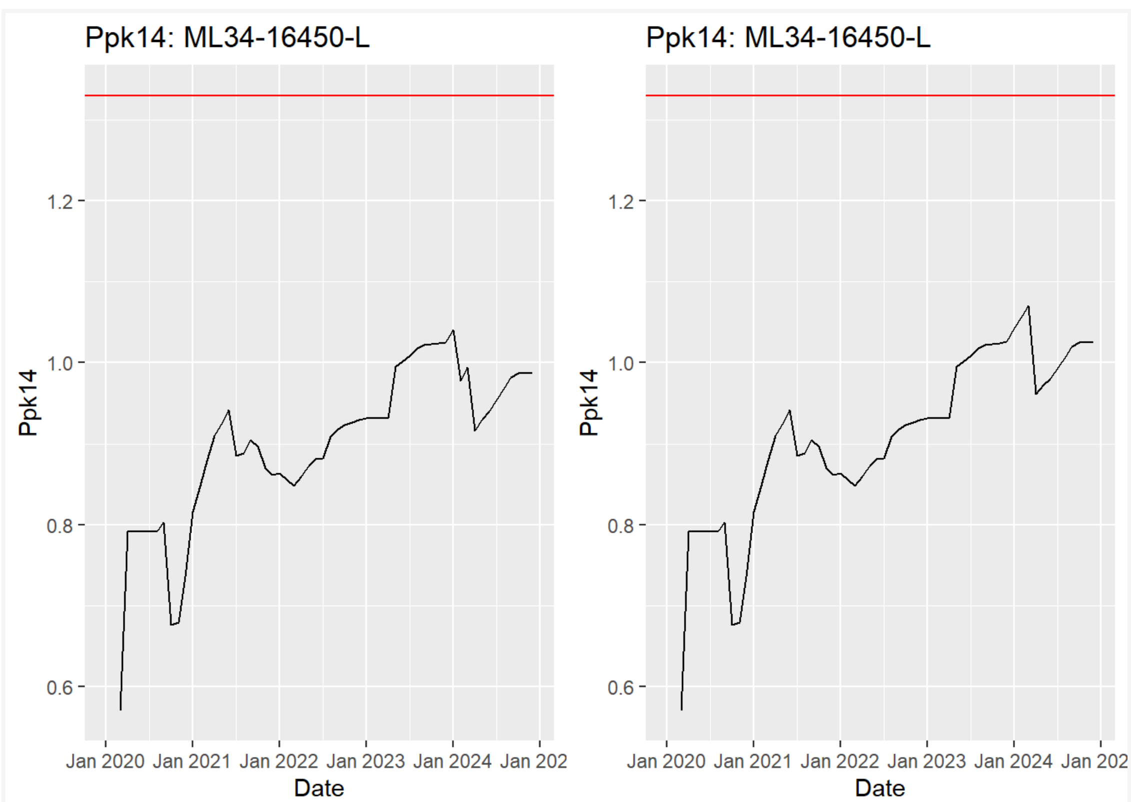
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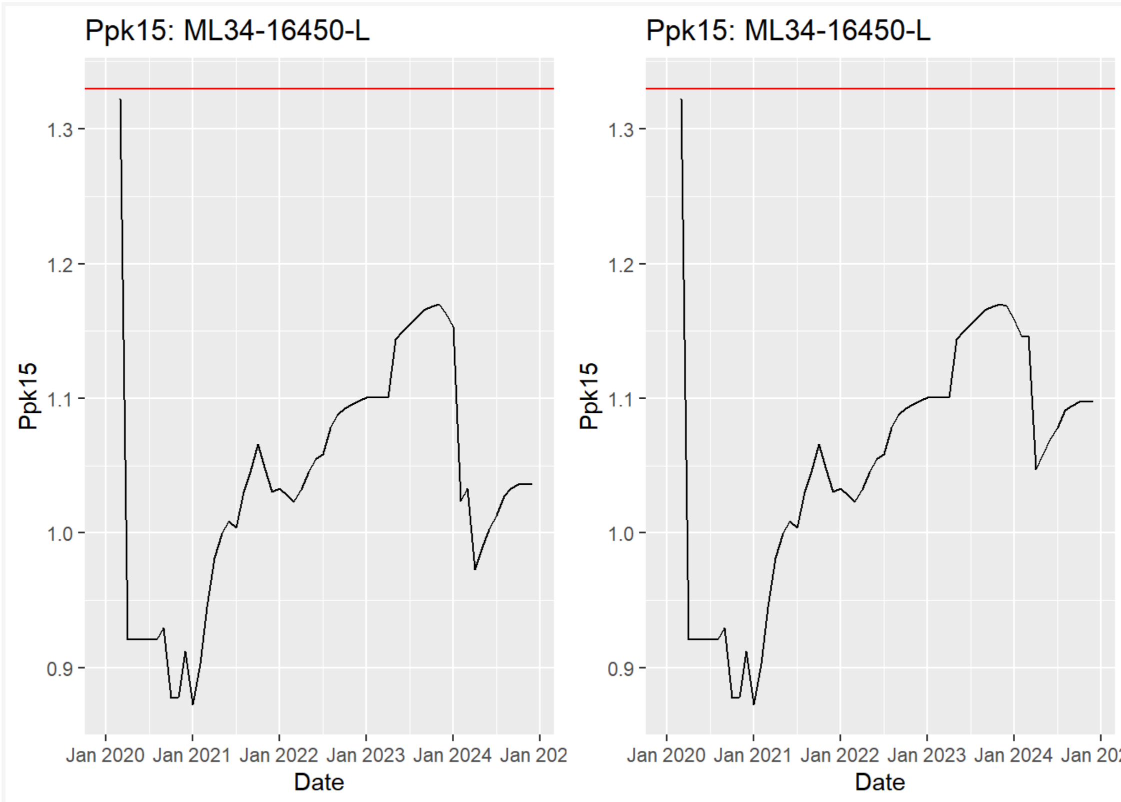
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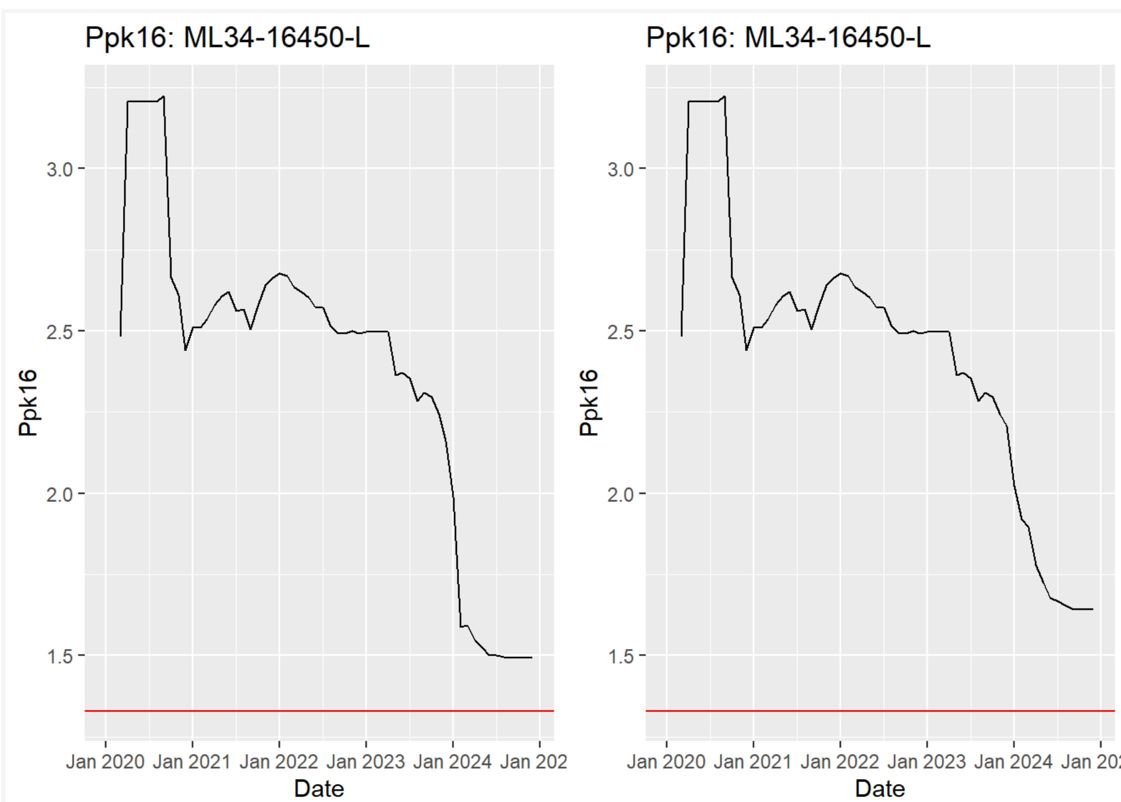
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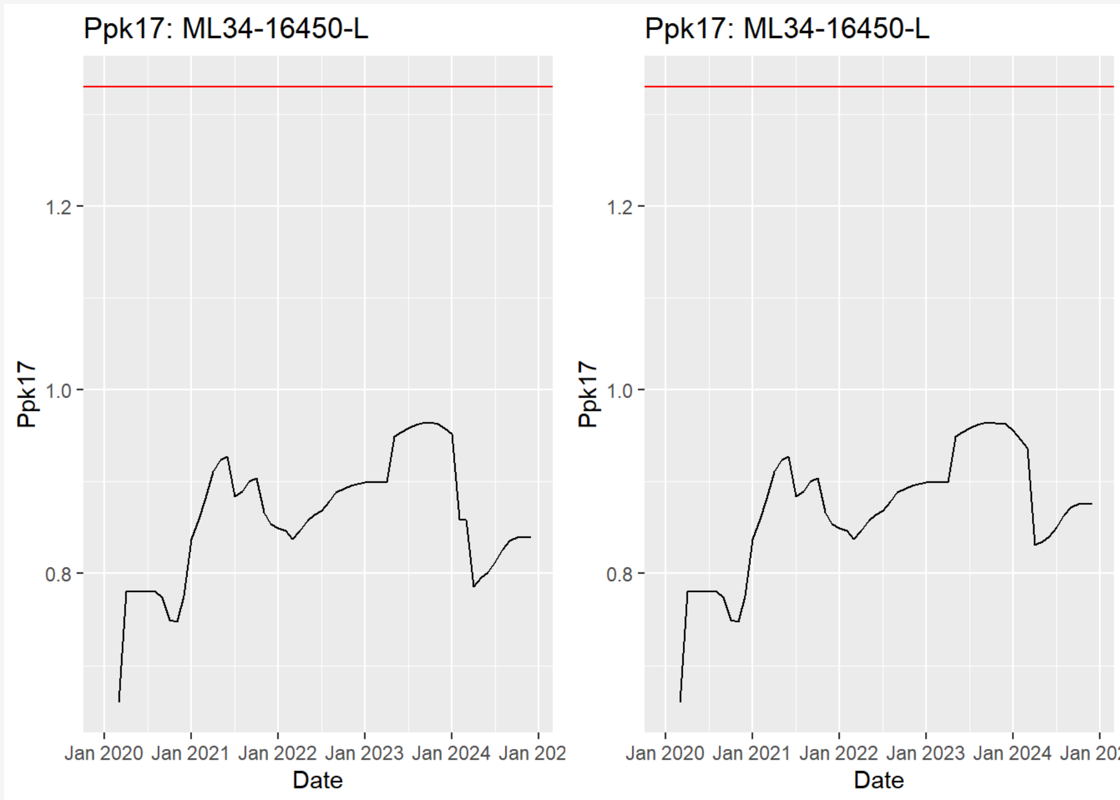
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date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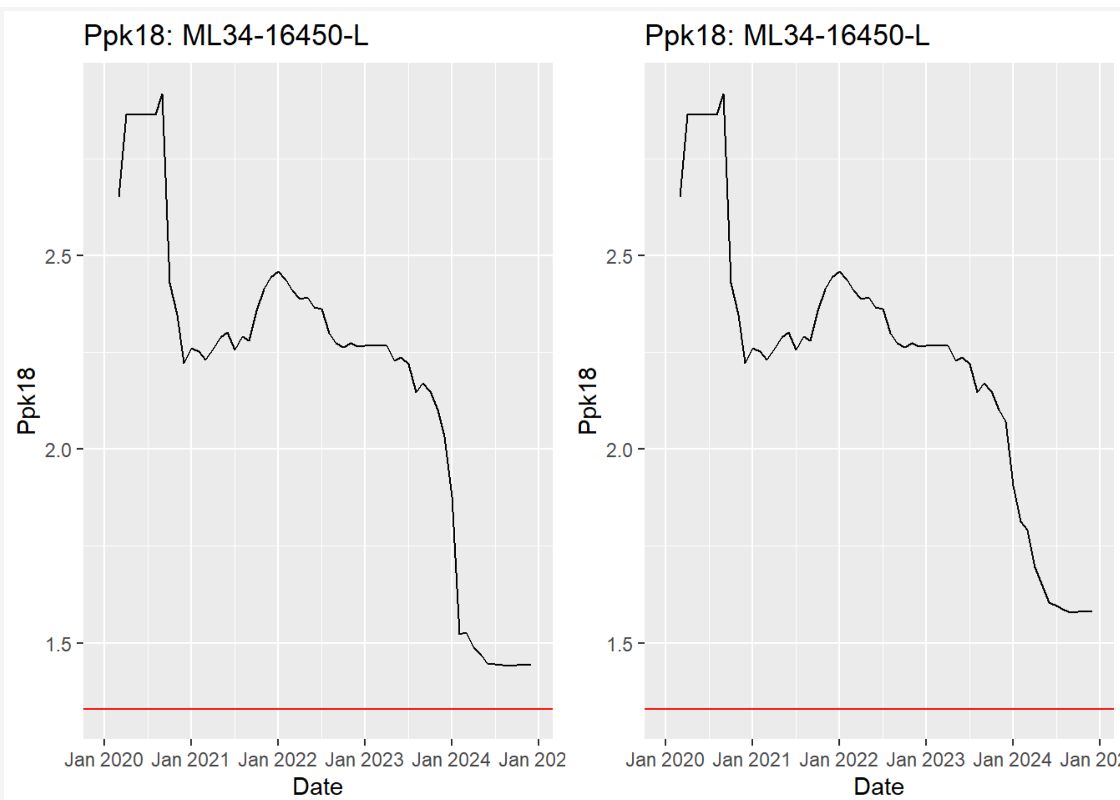
Ppk17
1.2
1.0
0.8
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk17: ML34-16450-L
Ppk17
1.2
1.0
0.8
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date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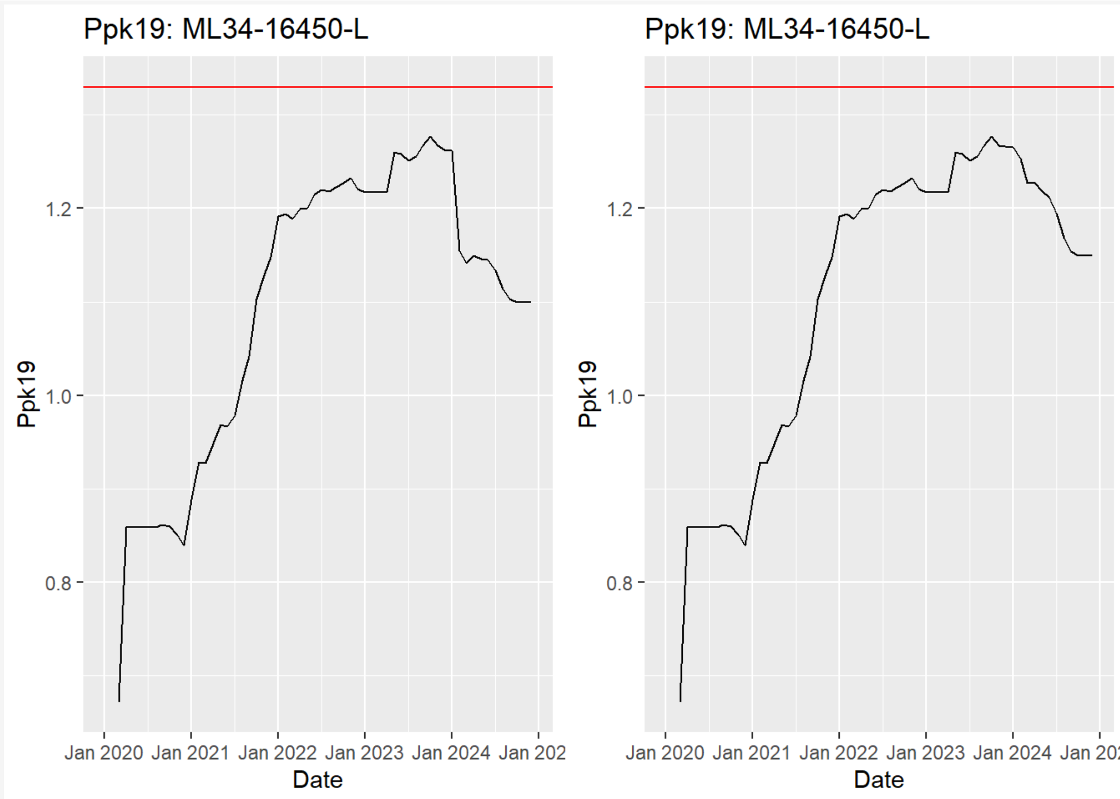
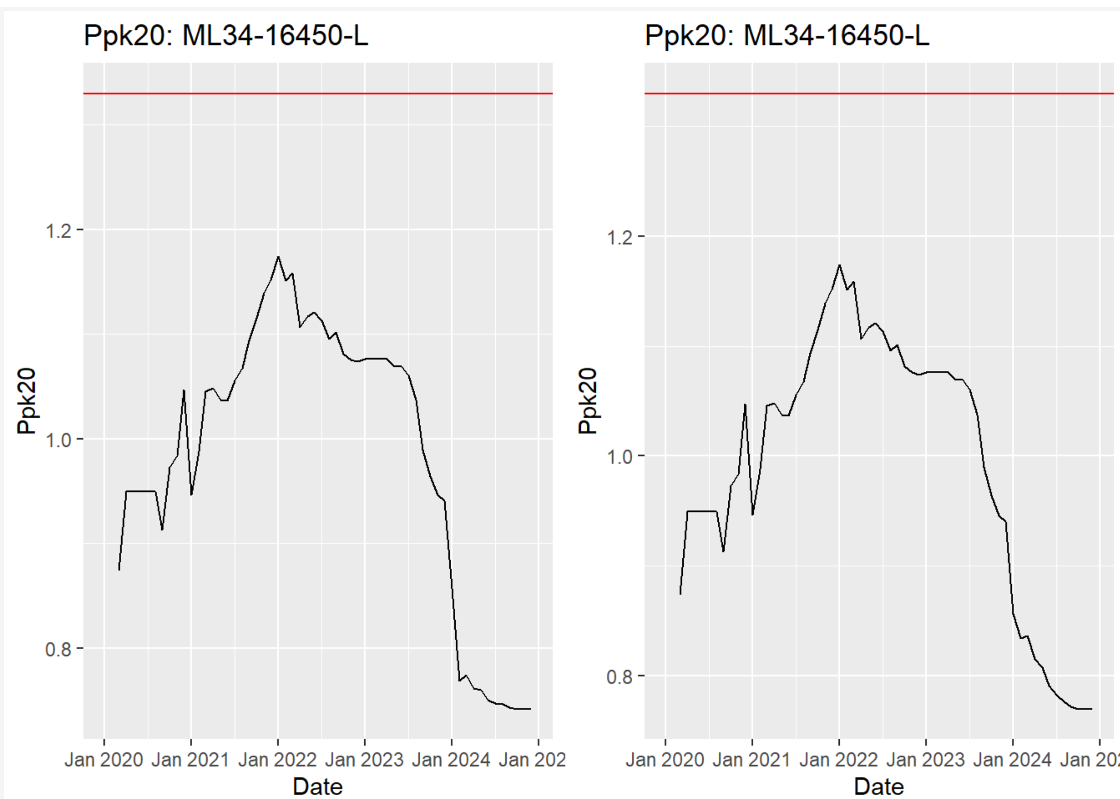
2.5
2.0
1.5
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk18: ML34-16450-L
Ppk18
2.5
2.0
1.5
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk19: ML34-16450-L
Ppk19: ML34-16450-L
Ppk19
0.8
1.0
1.2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date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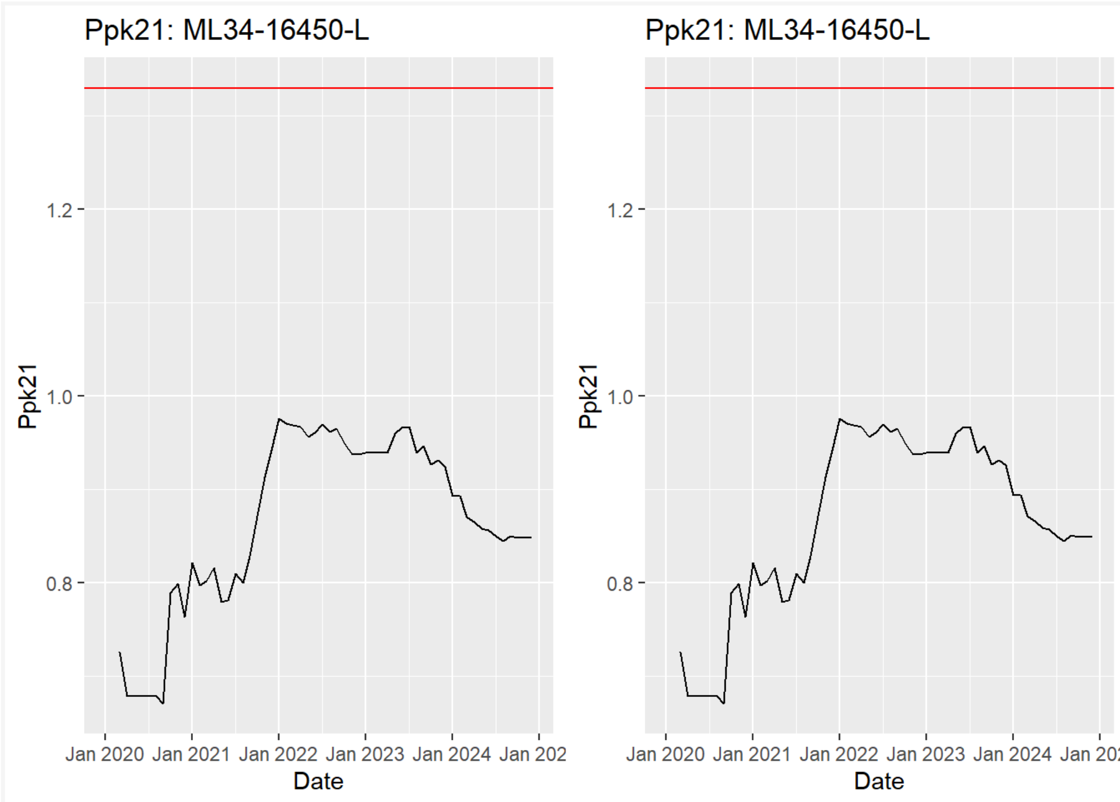
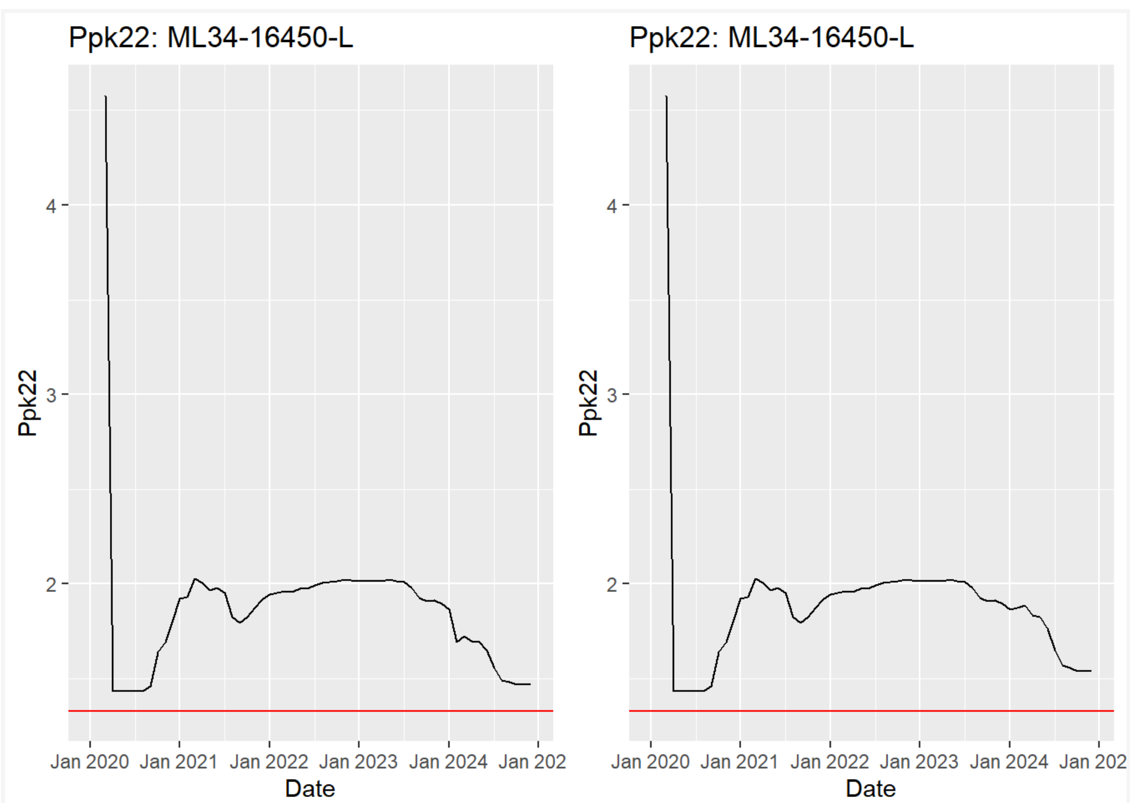
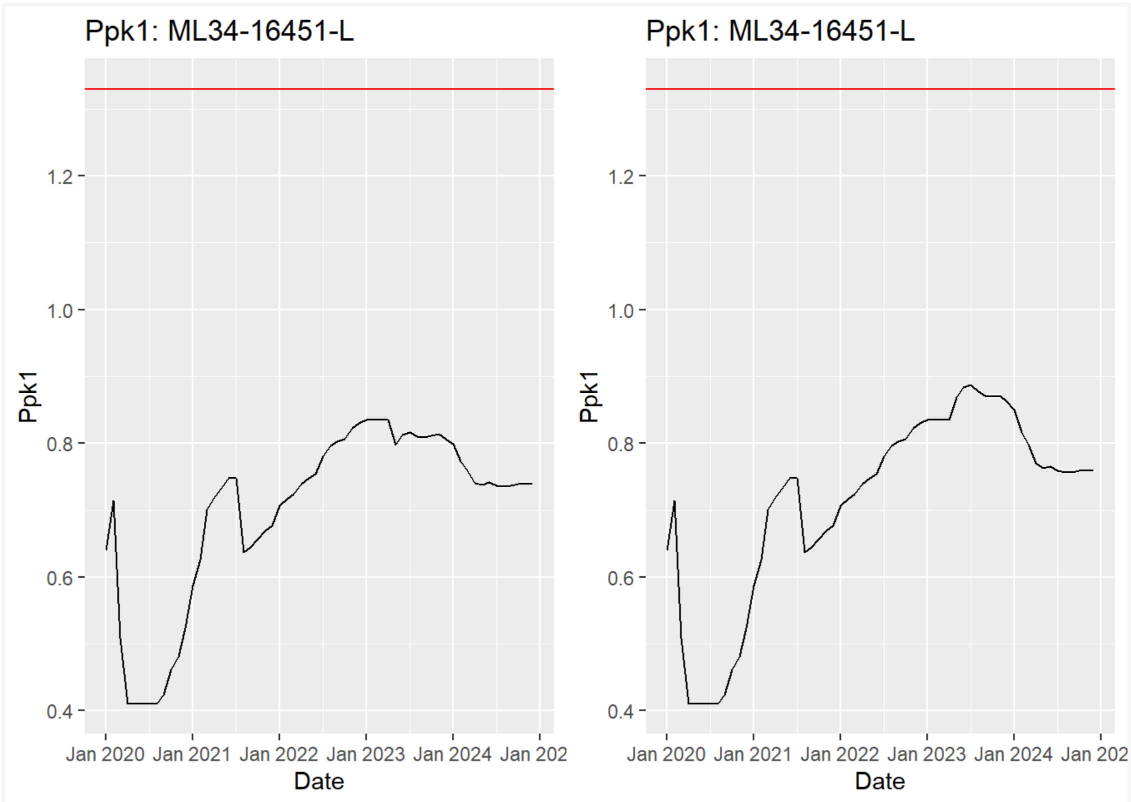
Ppk20: ML34-16450-L
Ppk20
0.8
1.0
1.2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date





Different with outliers (1,2,4,6,9,10,12,15); Good trajectory (1,2,4,6,8,11,12,14)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Ppk1: ML34-16451-L
Ppk1
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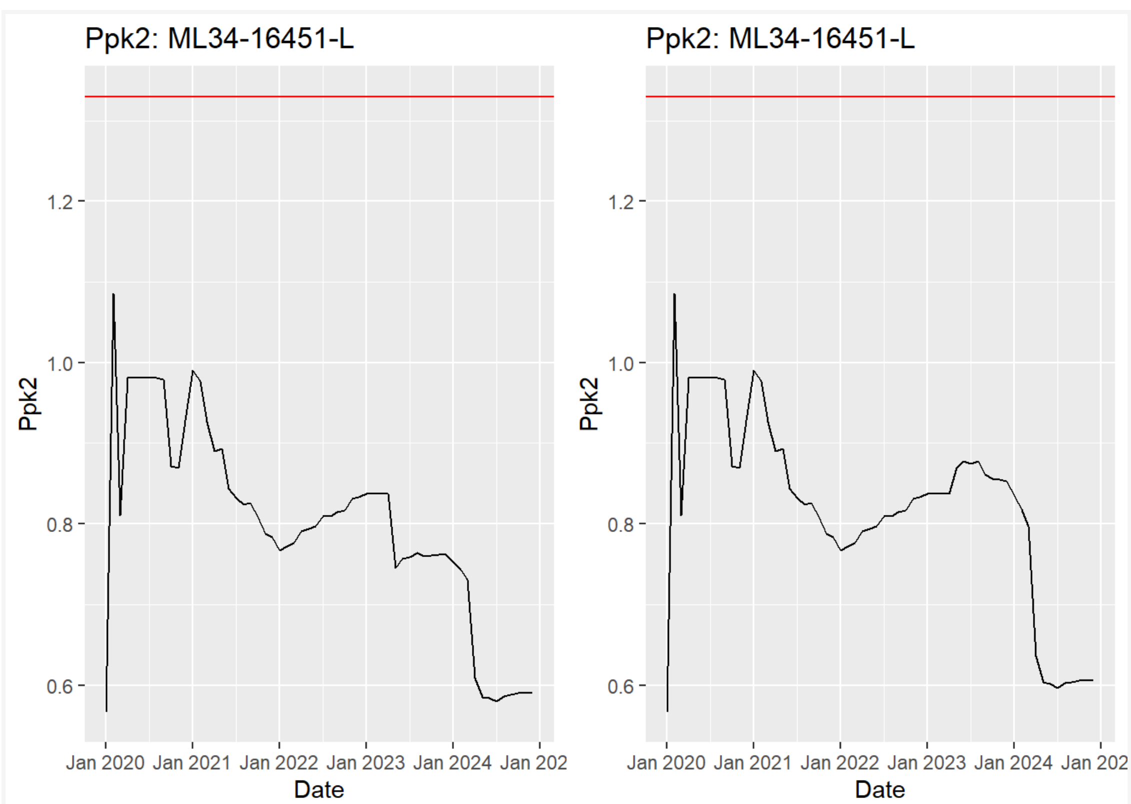
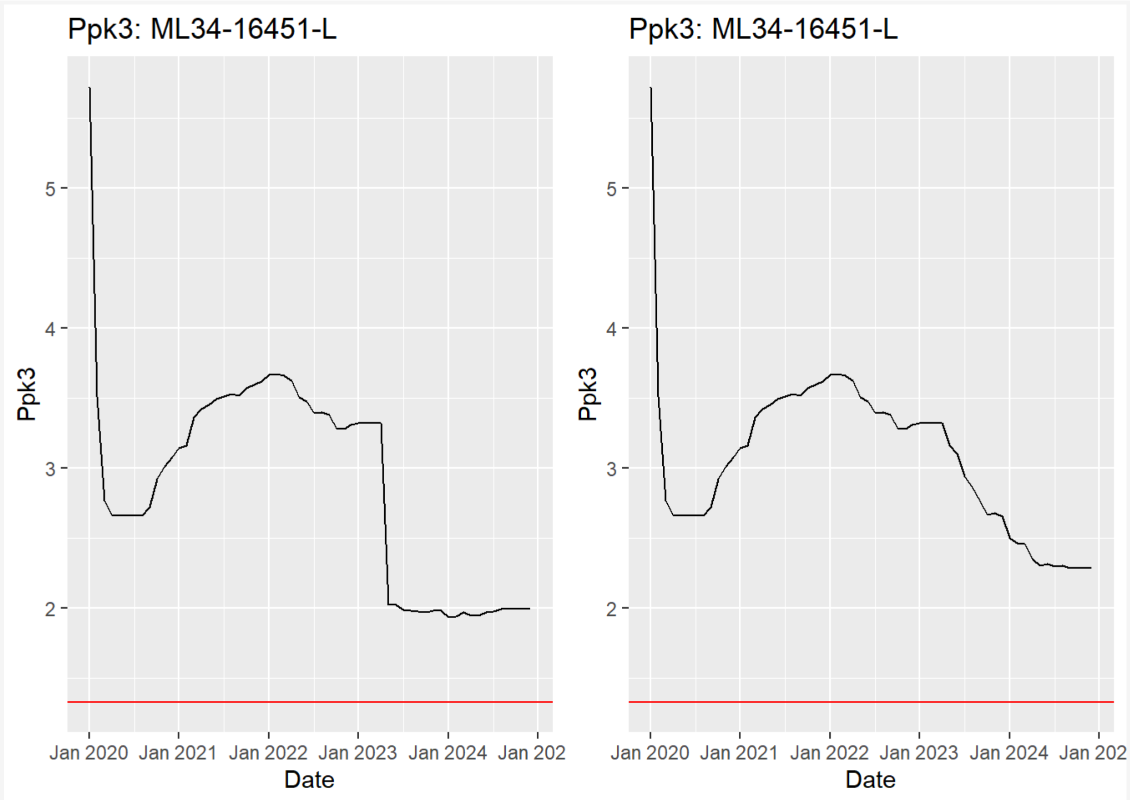
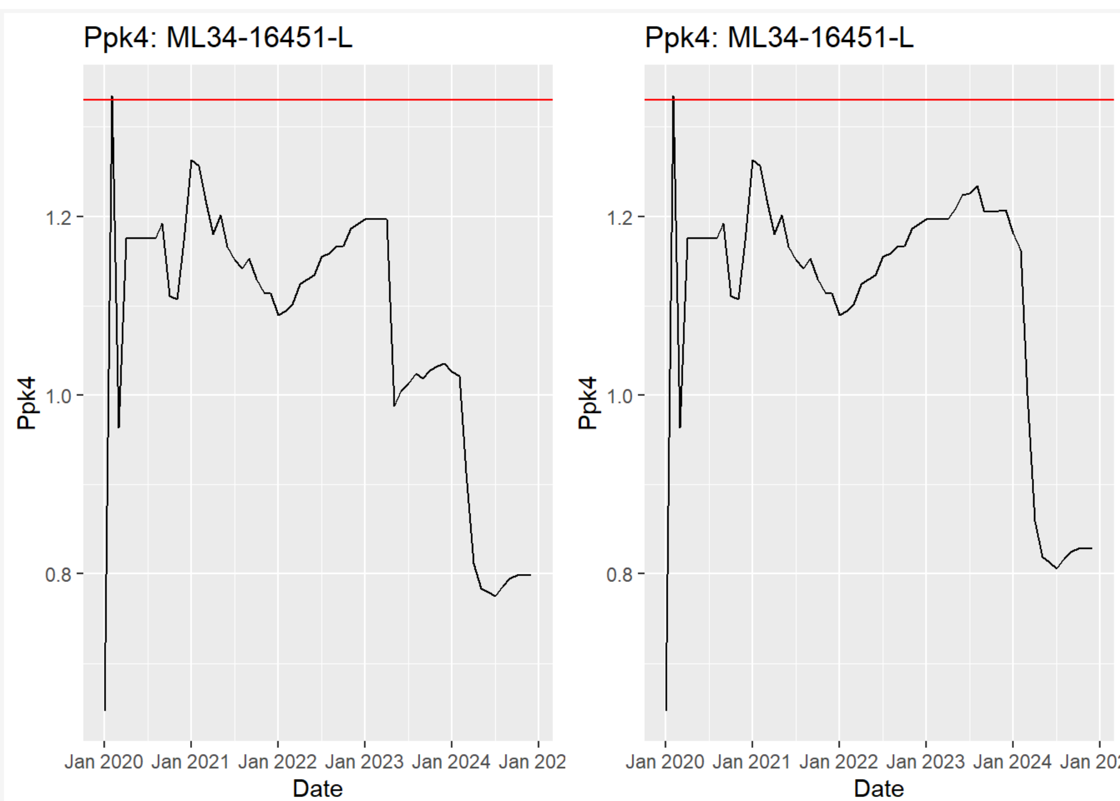
1.0
0.8
0.6
0.4
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk2: ML34-16451-L
Ppk2: ML34-16451-L
Ppk2
1.2
1.0
0.8
0.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk3: ML34-16451-L
Ppk3: ML34-16451-L
Ppk3
5
4
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk4: ML34-16451-L
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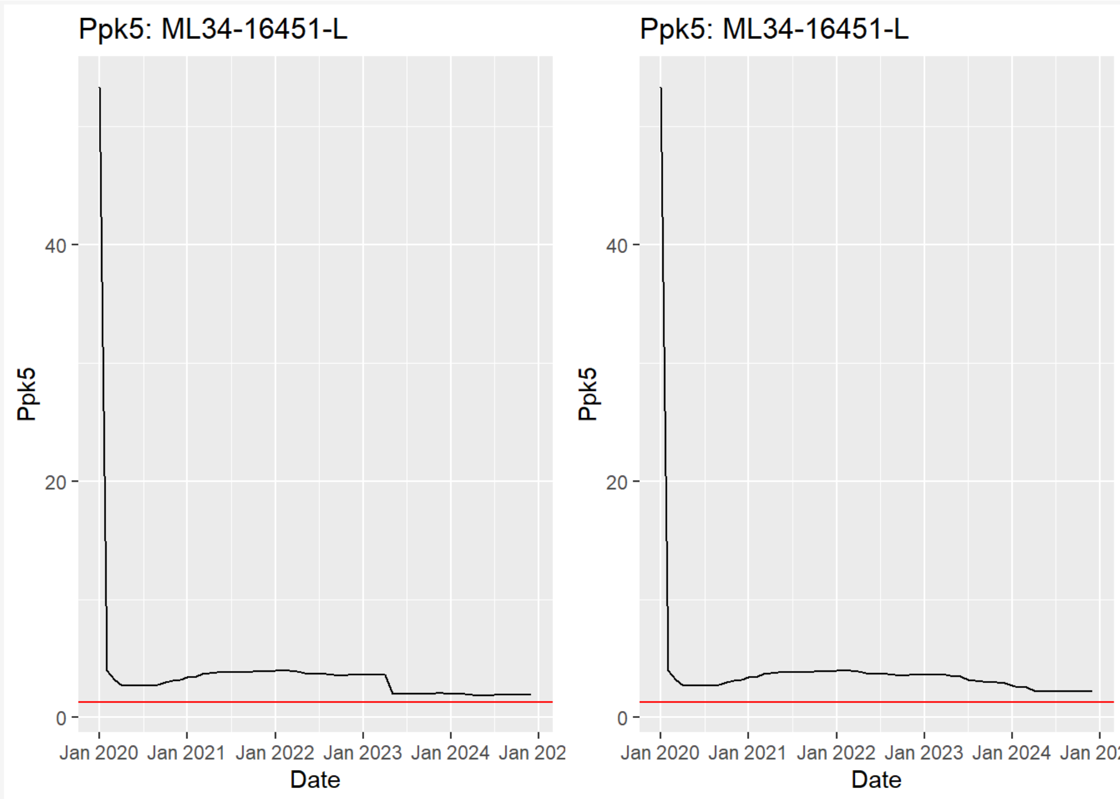
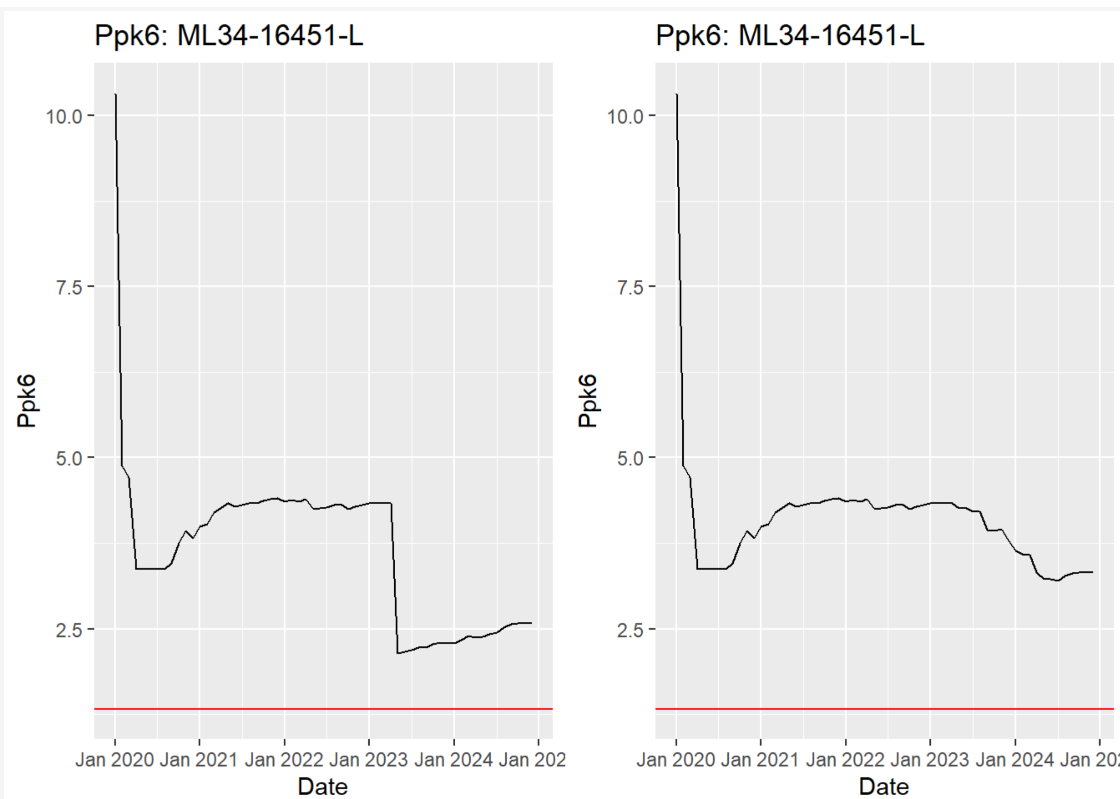
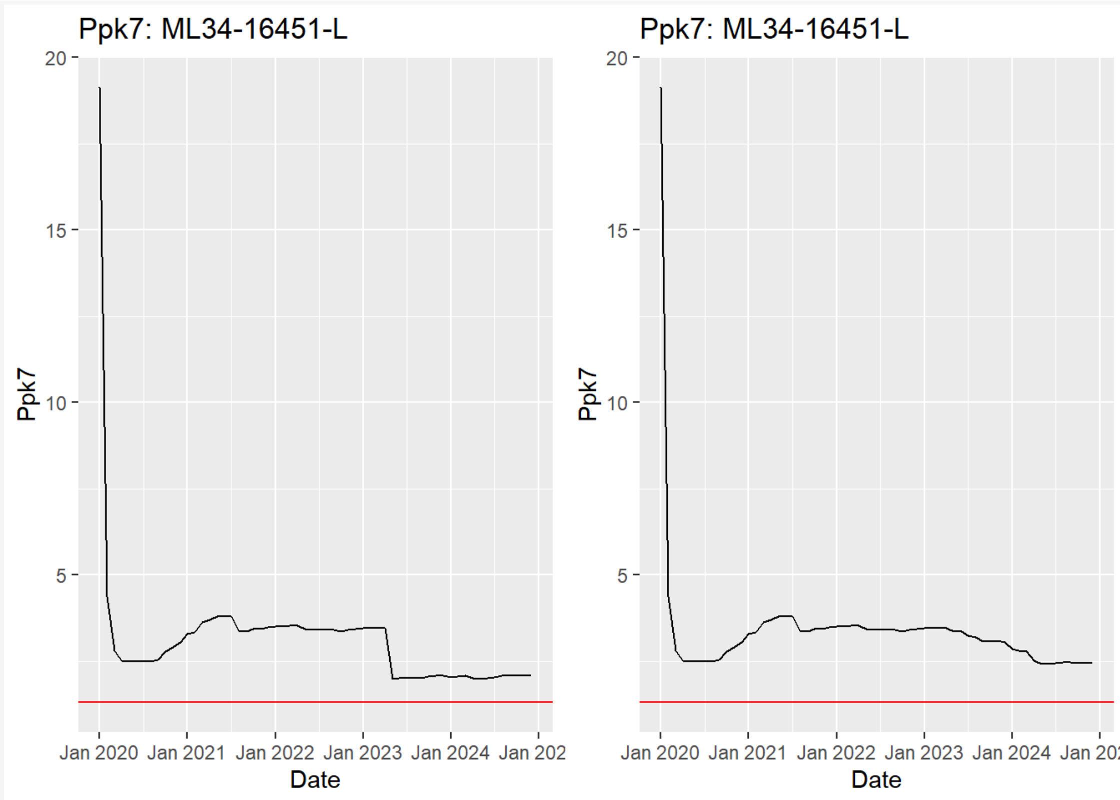
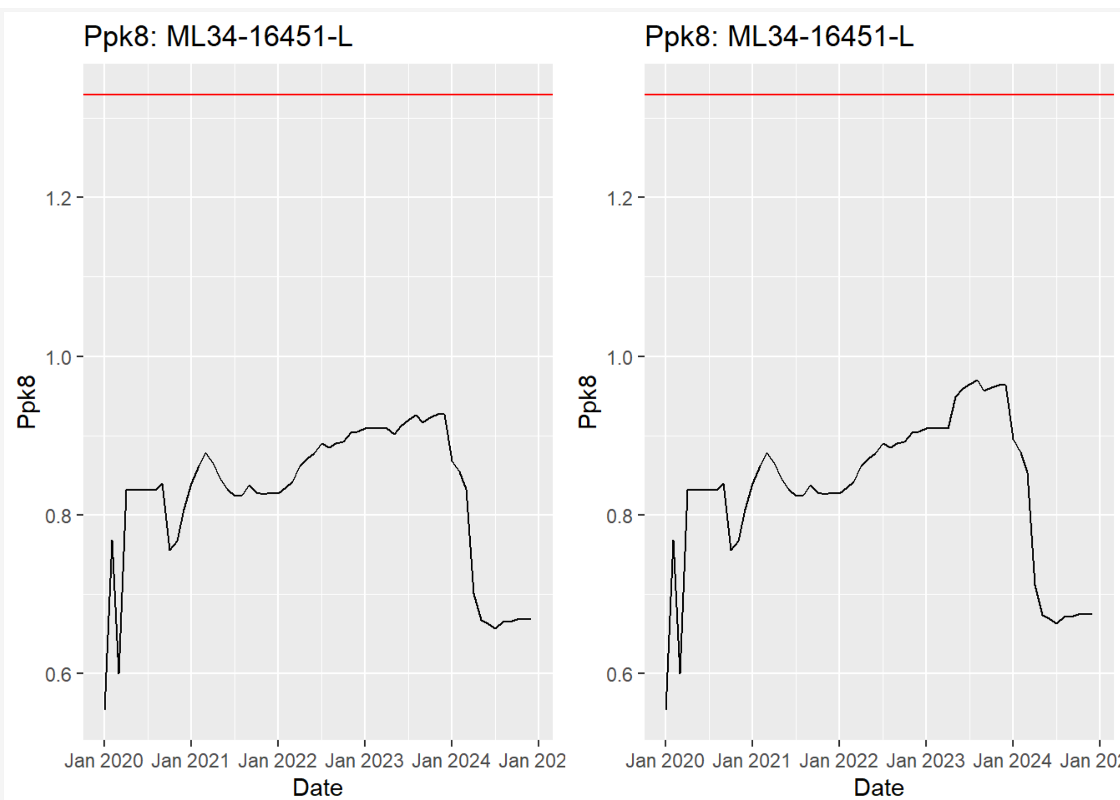
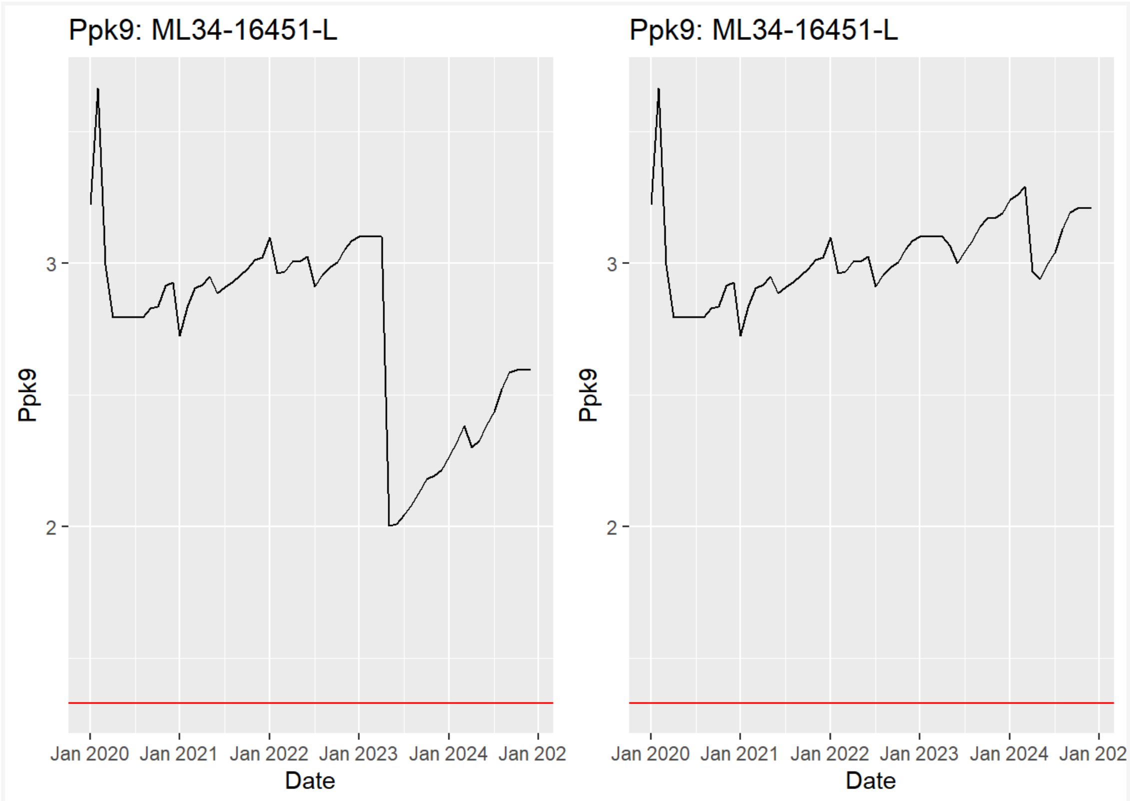
Ppk4
1.2
1.0
0.8
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

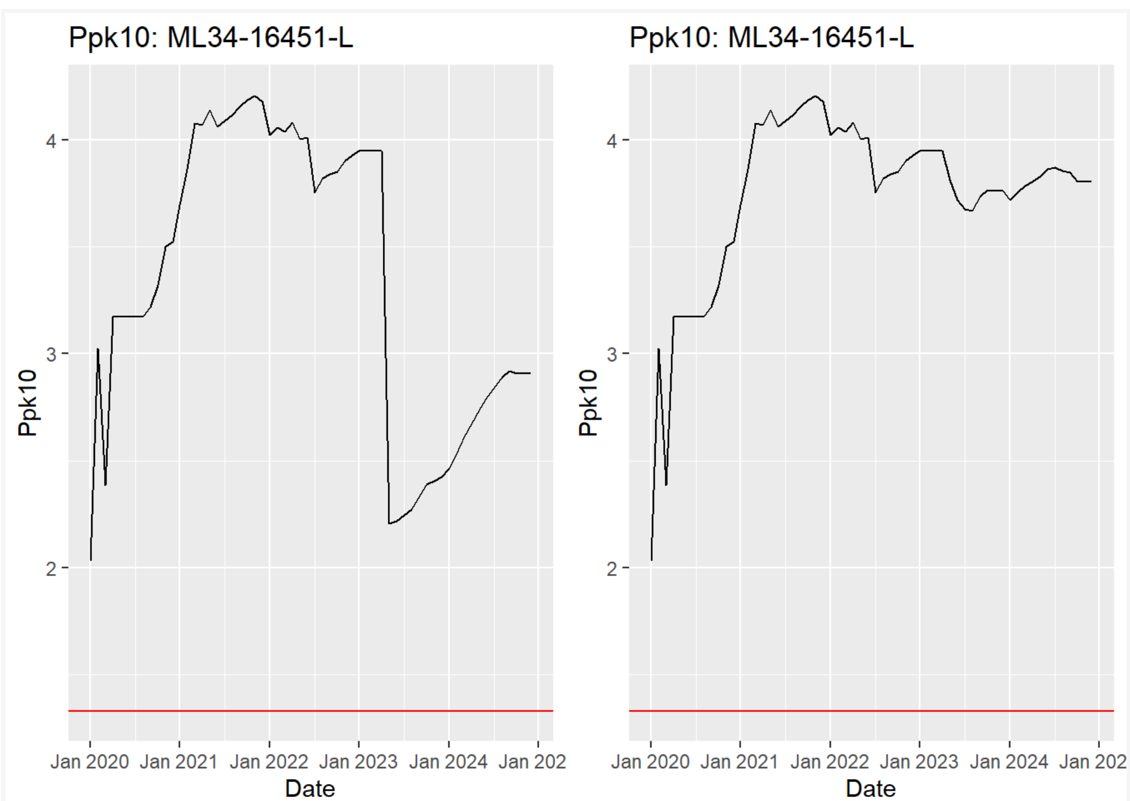

Ppk5: ML34-16451-L
Ppk5: ML34-16451-L
Ppk5
40
20
0
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

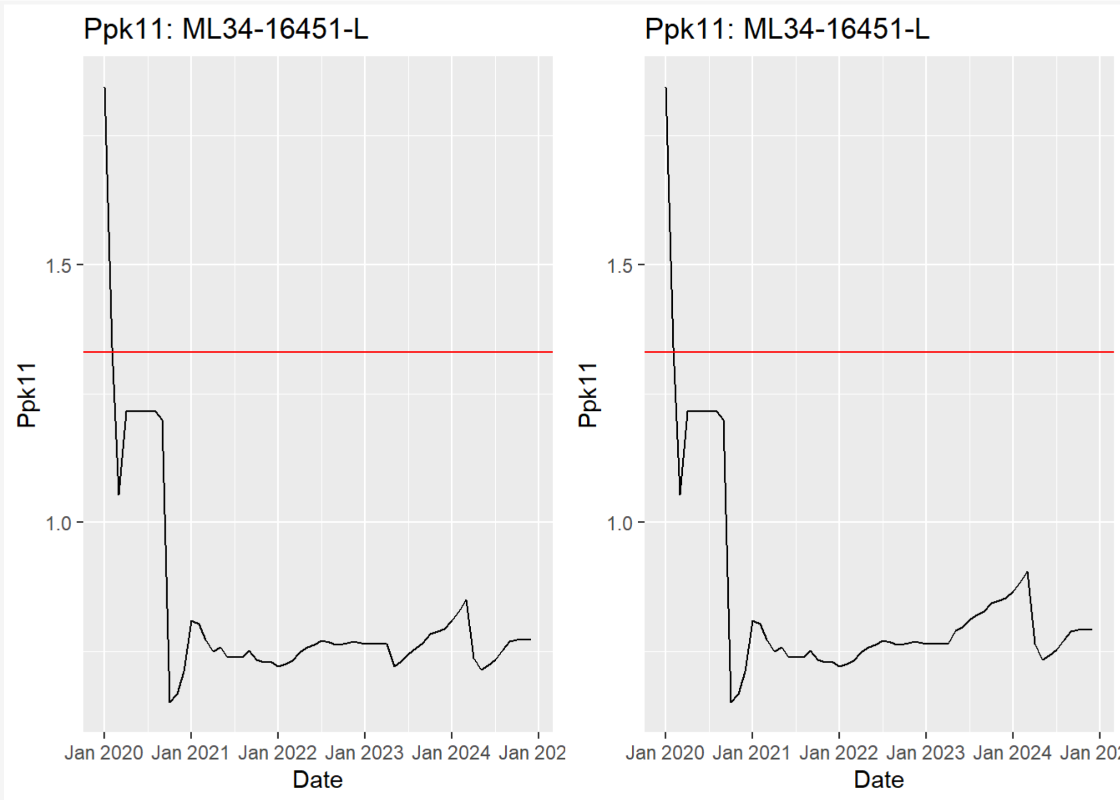

Ppk6: ML34-16451-L
Ppk6: ML34-16451-L
Ppk6
10.0
7.5
5.0
2.5
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk7: ML34-16451-L
Ppk7: ML34-16451-L
20
15
10
5
Ppk7
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk8: ML34-16451-L
Ppk8: ML34-16451-L
1.2
1.0
0.8
0.6
Ppk8
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk9: ML34-16451-L
Ppk9
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk9: ML34-16451-L
Ppk9
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk10: ML34-16451-L
Ppk10
4
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk10: ML34-16451-L
Ppk10
4
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date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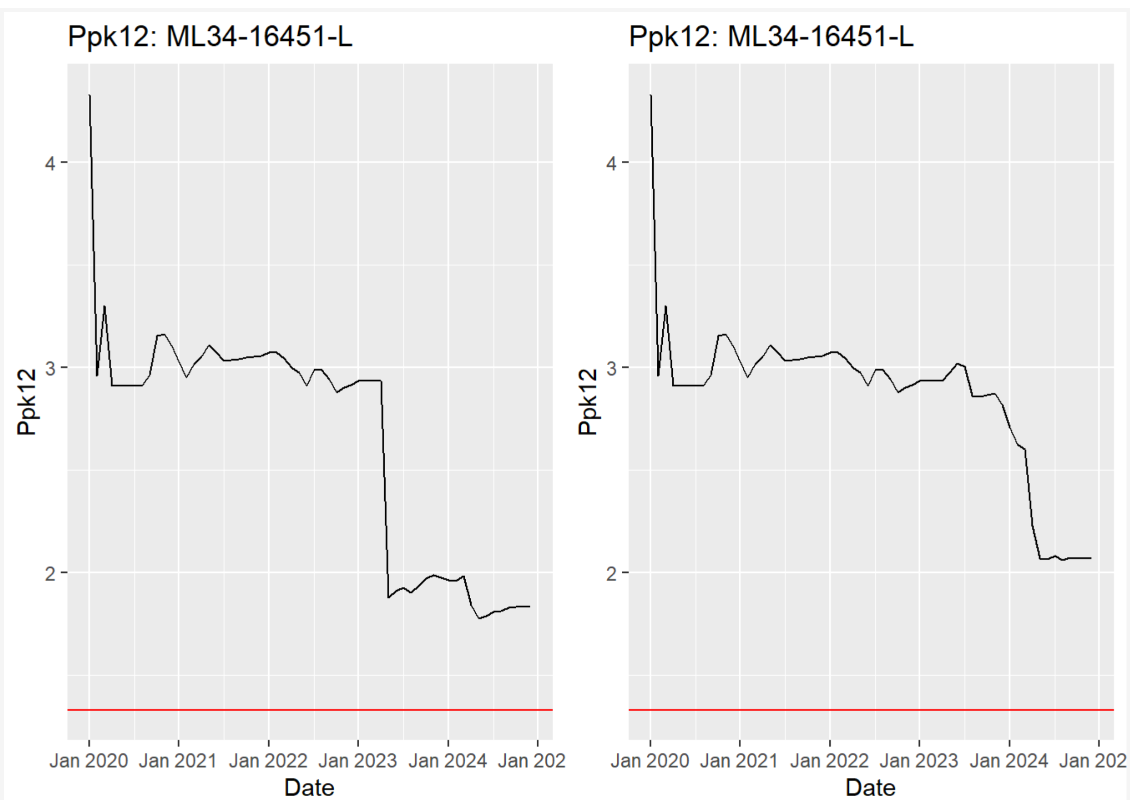
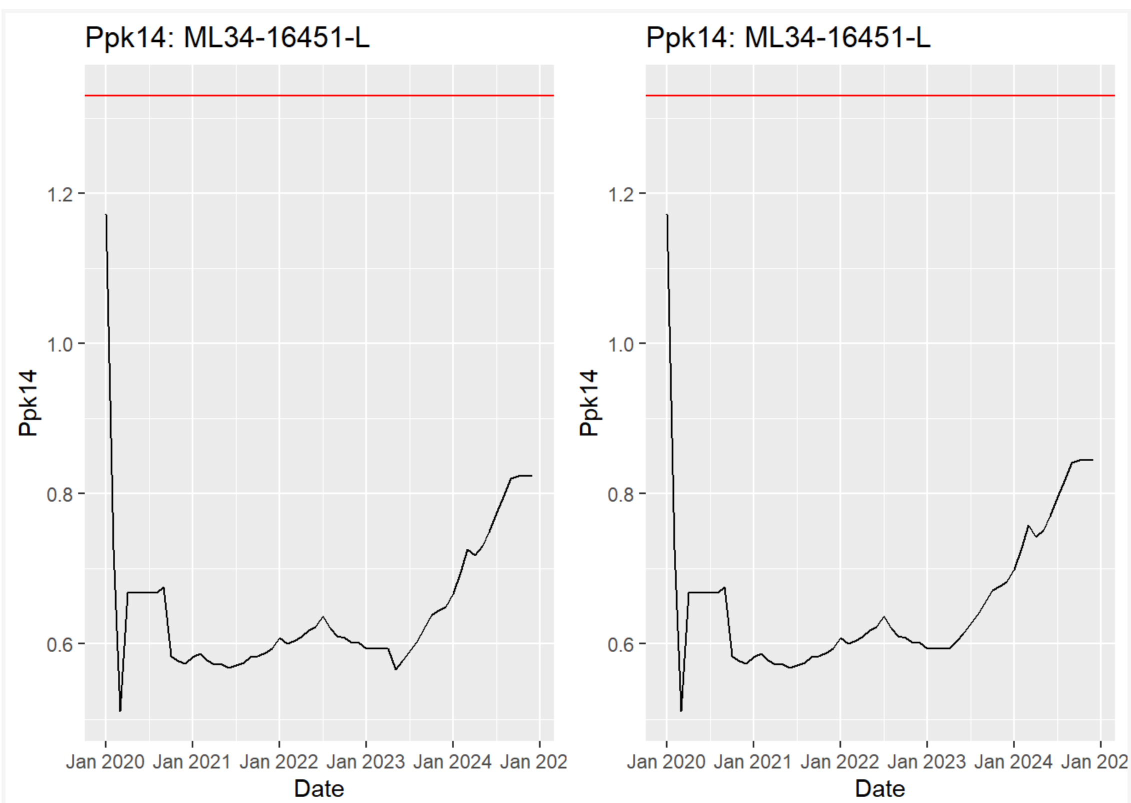
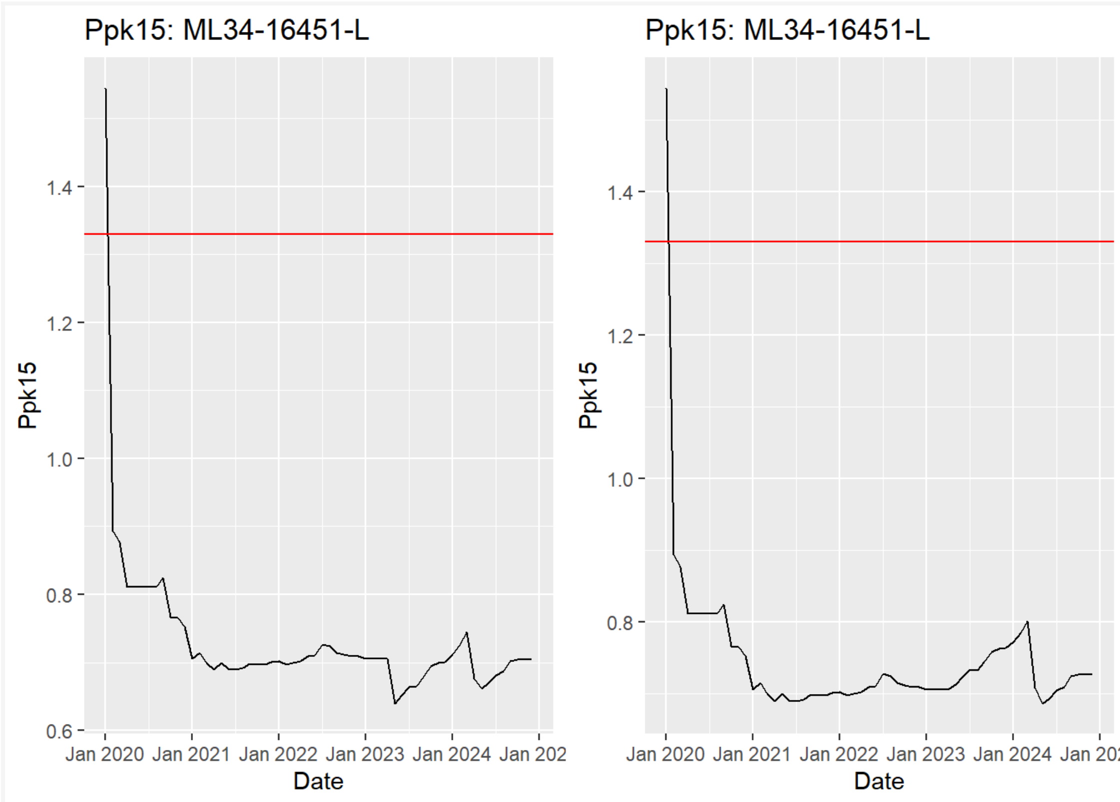
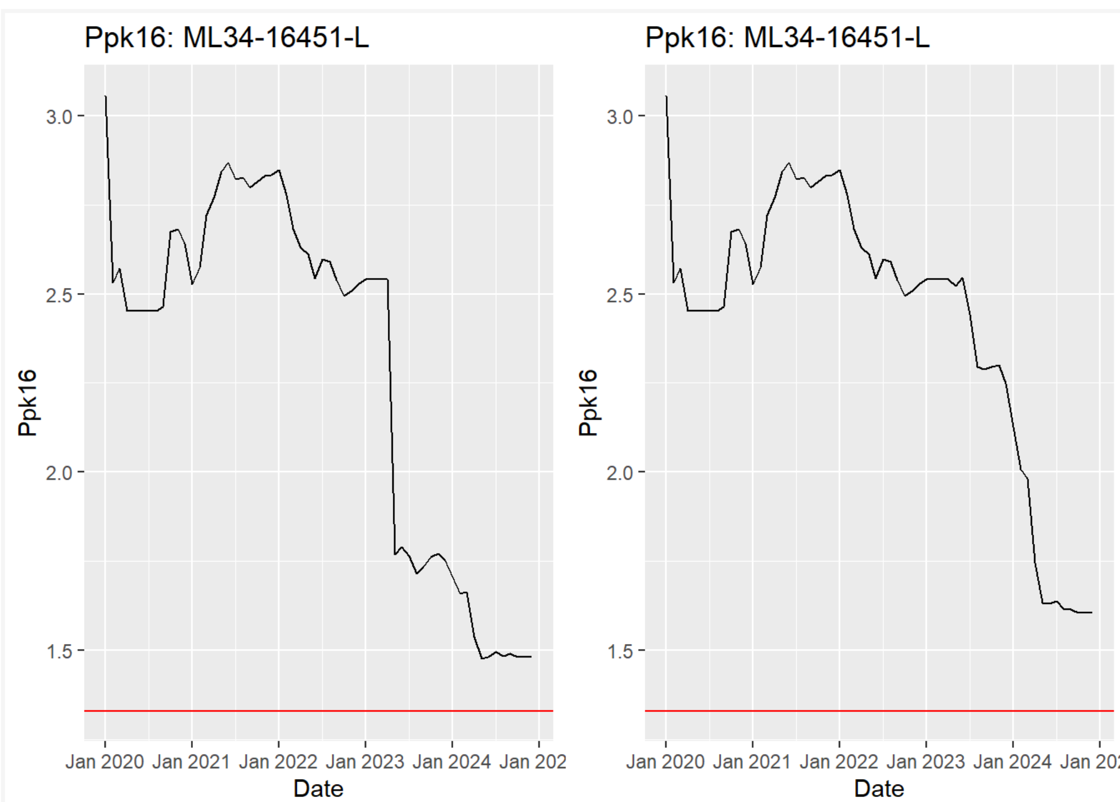
1.5
1.0
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

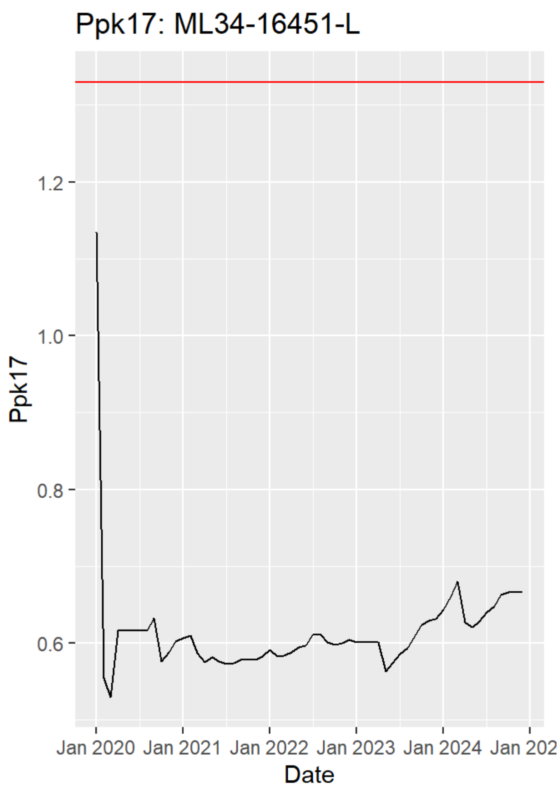

Ppk12: ML34-16451-L
Ppk12: ML34-16451-L
Ppk12
4
3
2
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

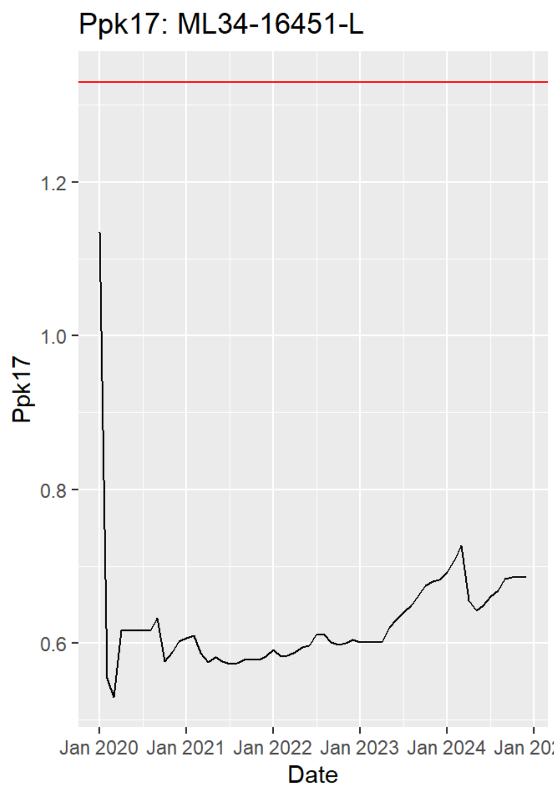

Ppk13: ML34-16451-L
Ppk13: ML34-16451-L
3.5
3.0
2.5
2.0
1.5
Ppk13
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

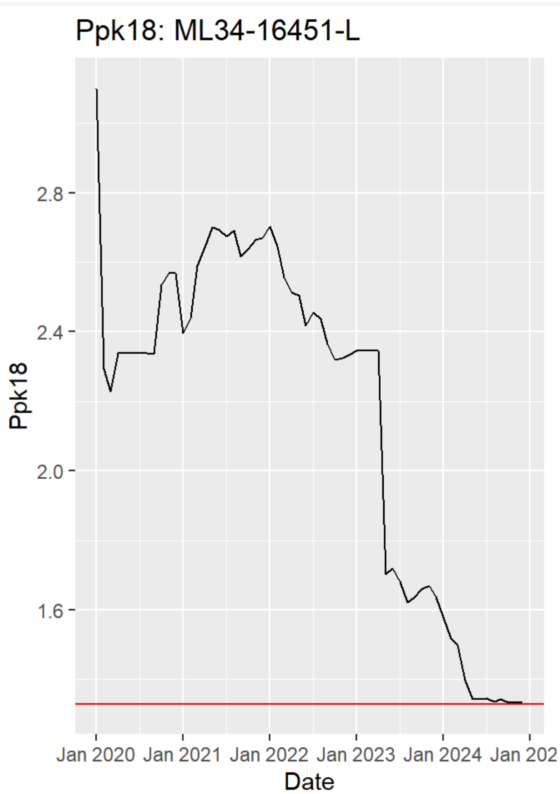

Ppk14: ML34-16451-L
Ppk14: ML34-16451-L
1.2
1.0
0.8
0.6
Ppk14
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

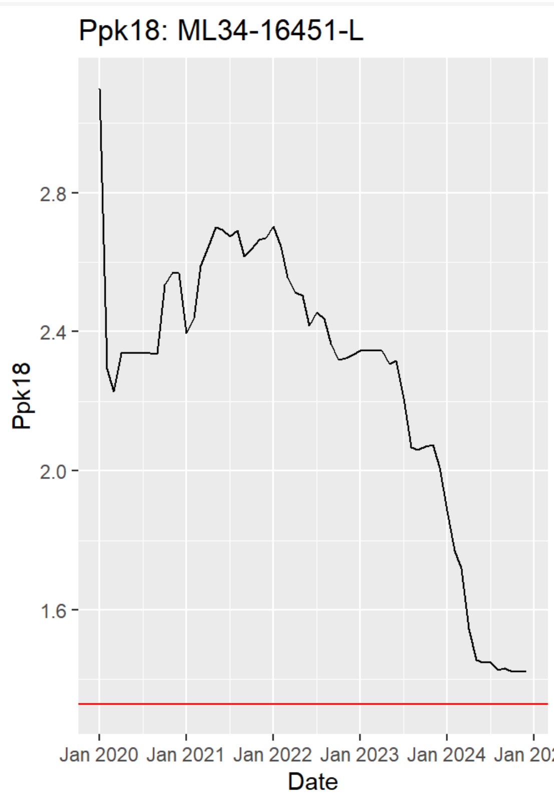

Ppk15: ML34-16451-L
Ppk15
1.4
1.2
1.0
0.8
0.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk15: ML34-16451-L
Ppk15
1.4
1.2
1.0
0.8
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

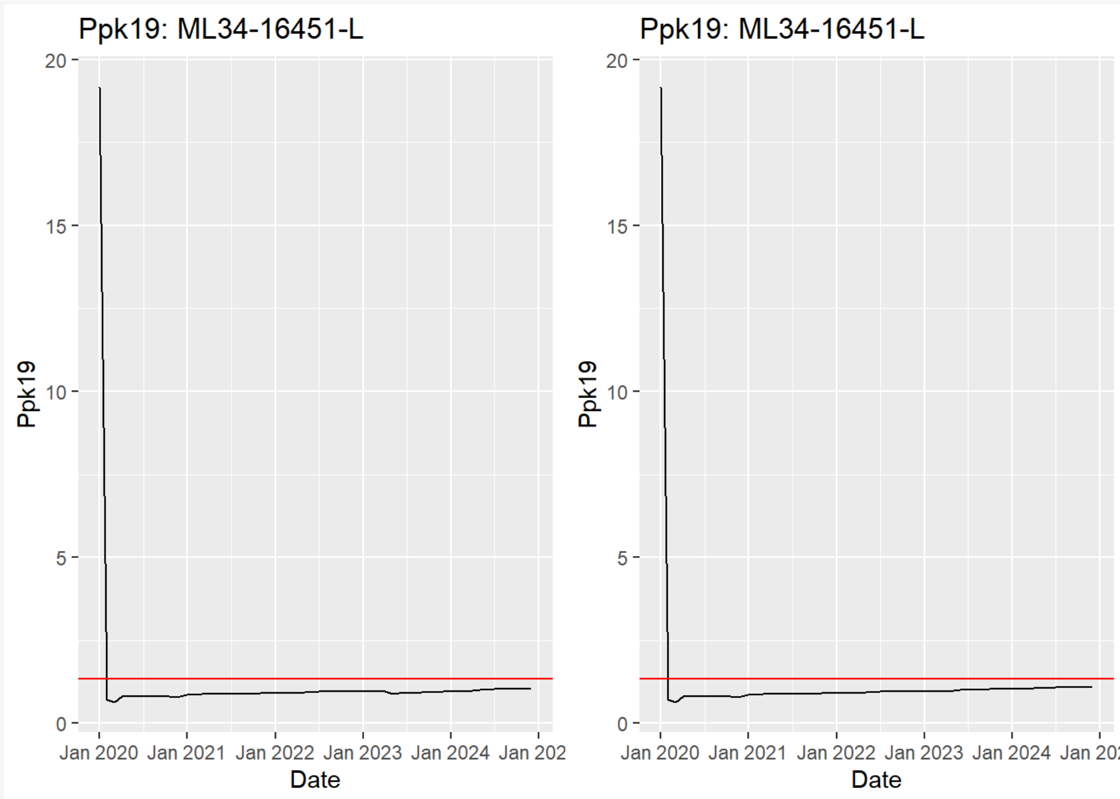

Ppk16: ML34-16451-L
Ppk16
3.0
2.5
2.0
1.5
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk16: ML34-16451-L
Ppk16
3.0
2.5
2.0
1.5
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date

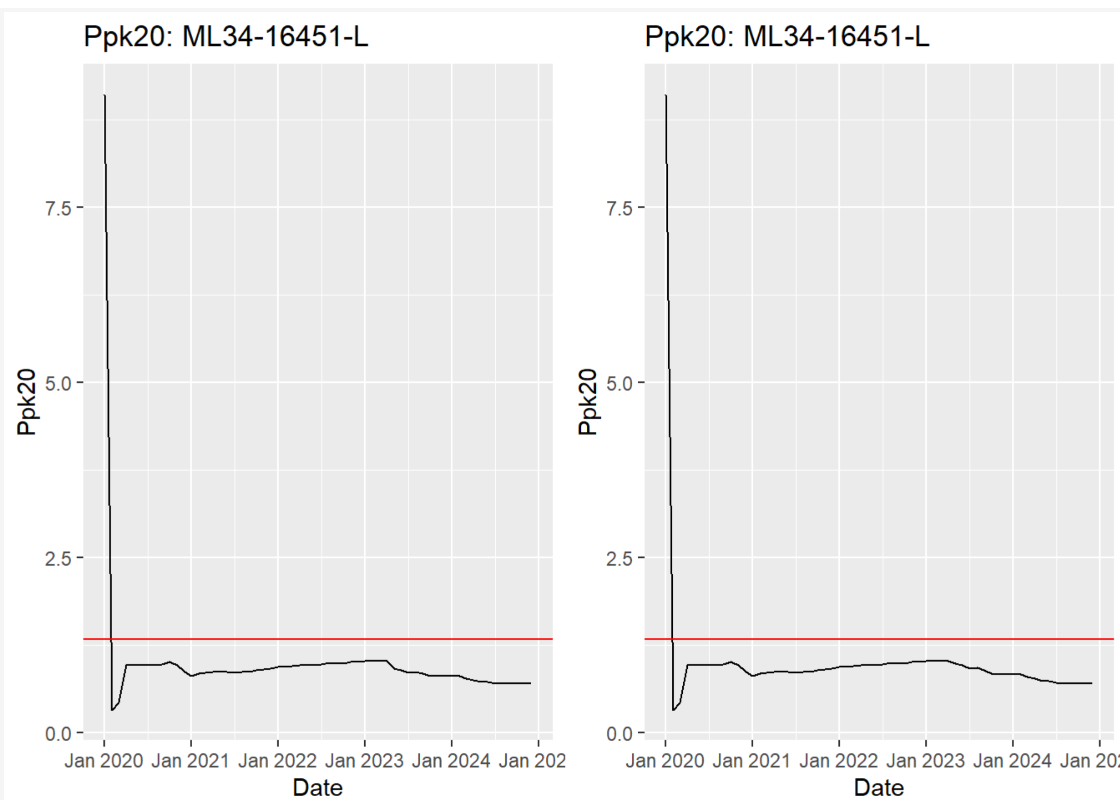

Ppk17: ML34-16451-L
Ppk17
1.2
1.0
0.8
0.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk17: ML34-16451-L
Ppk17
1.2
1.0
0.8
0.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk18: ML34-16451-L
Ppk18
2.8
2.4
2.0
1.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk18: ML34-16451-L
Ppk18
2.8
2.4
2.0
1.6
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk19: ML34-16451-L
Ppk19
20
15
10
5
0
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
Ppk19: ML34-16451-L
Ppk19
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date


Ppk20: ML34-16451-L
Ppk20
7.5
5.0
2.5
0.0
Jan 2020 Jan 2021 Jan 2022 Jan 2023 Jan 2024 Jan 202
Date
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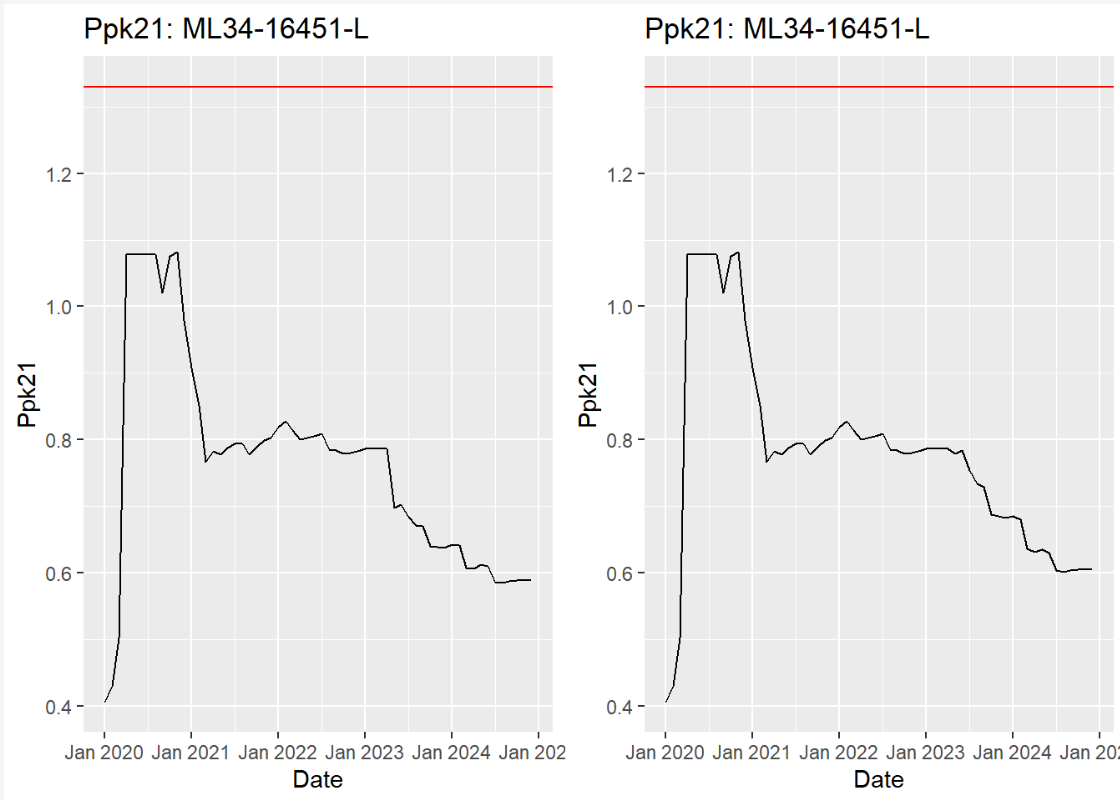
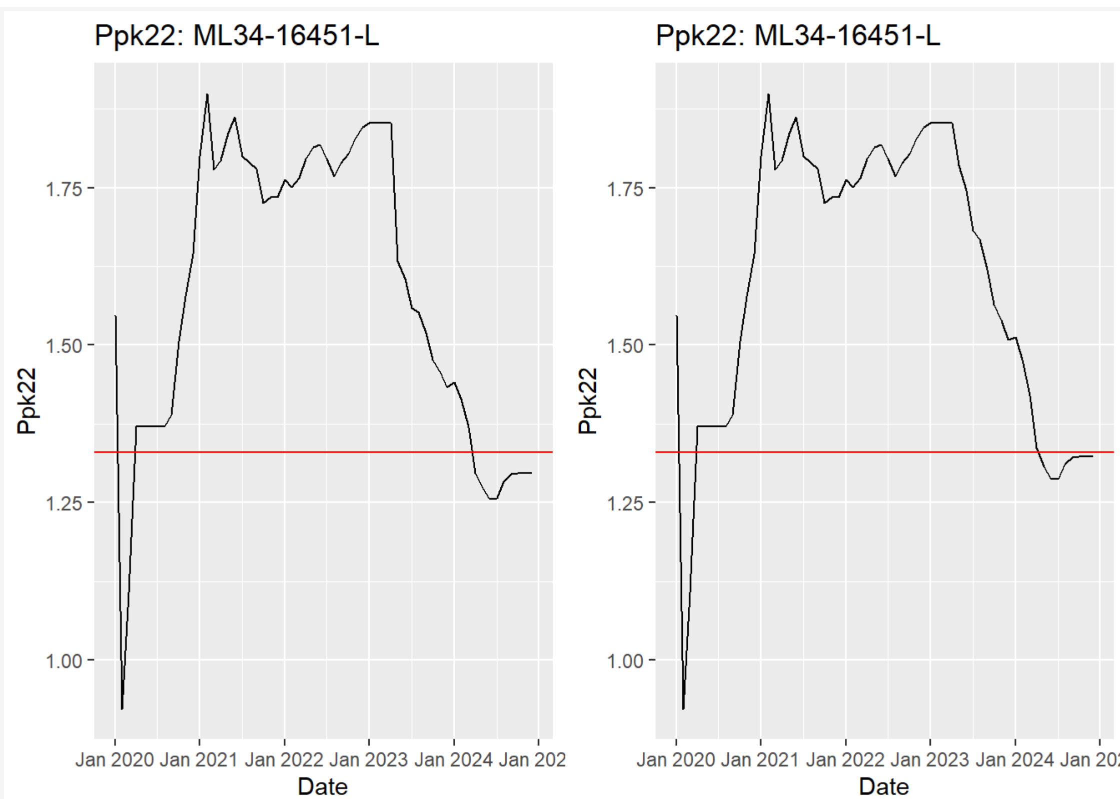
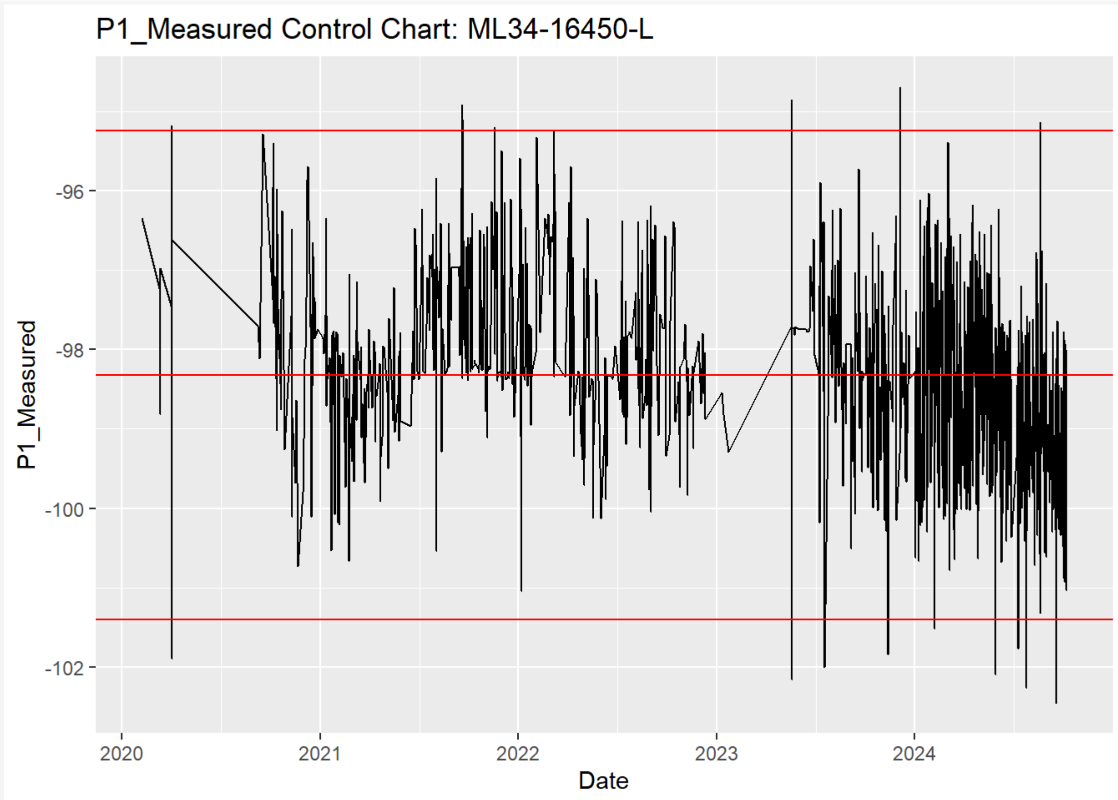
Date

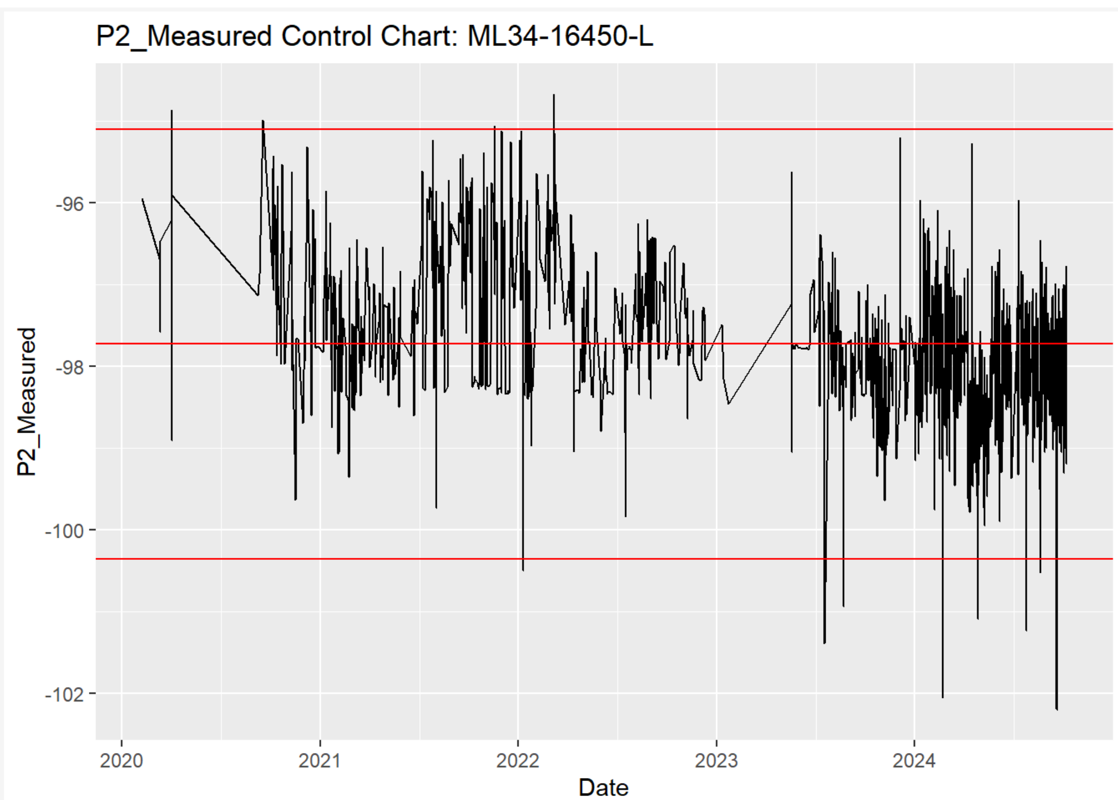


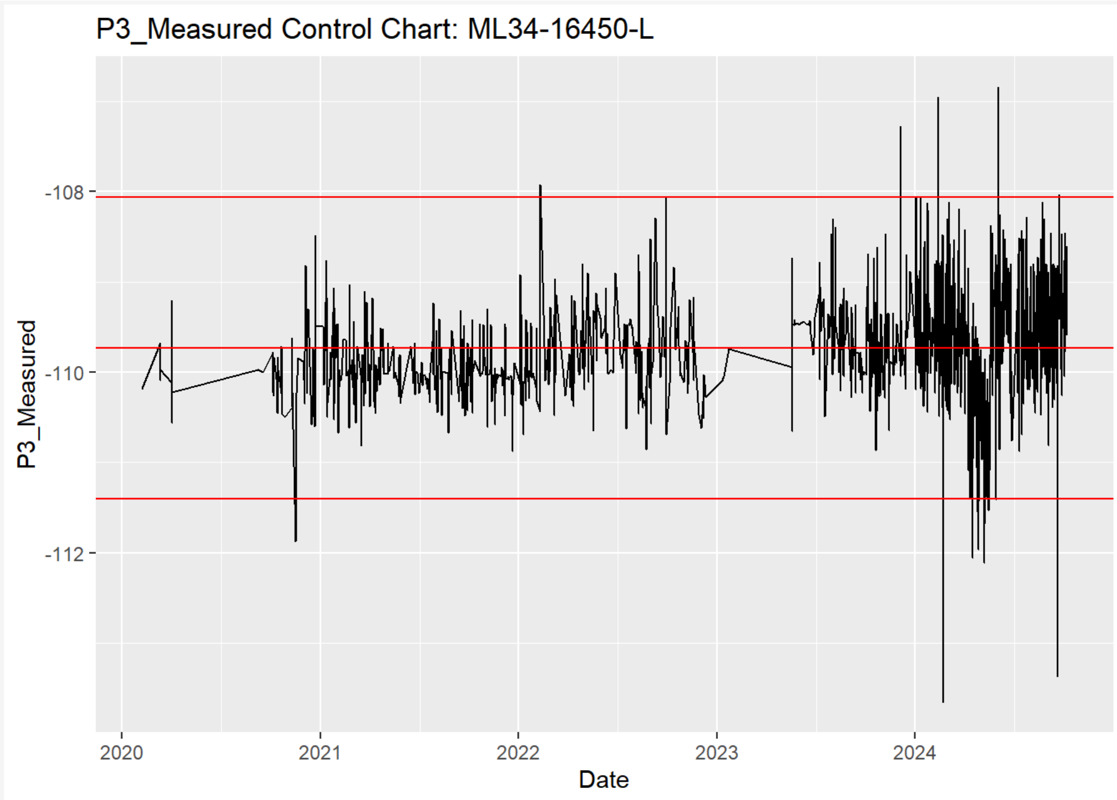


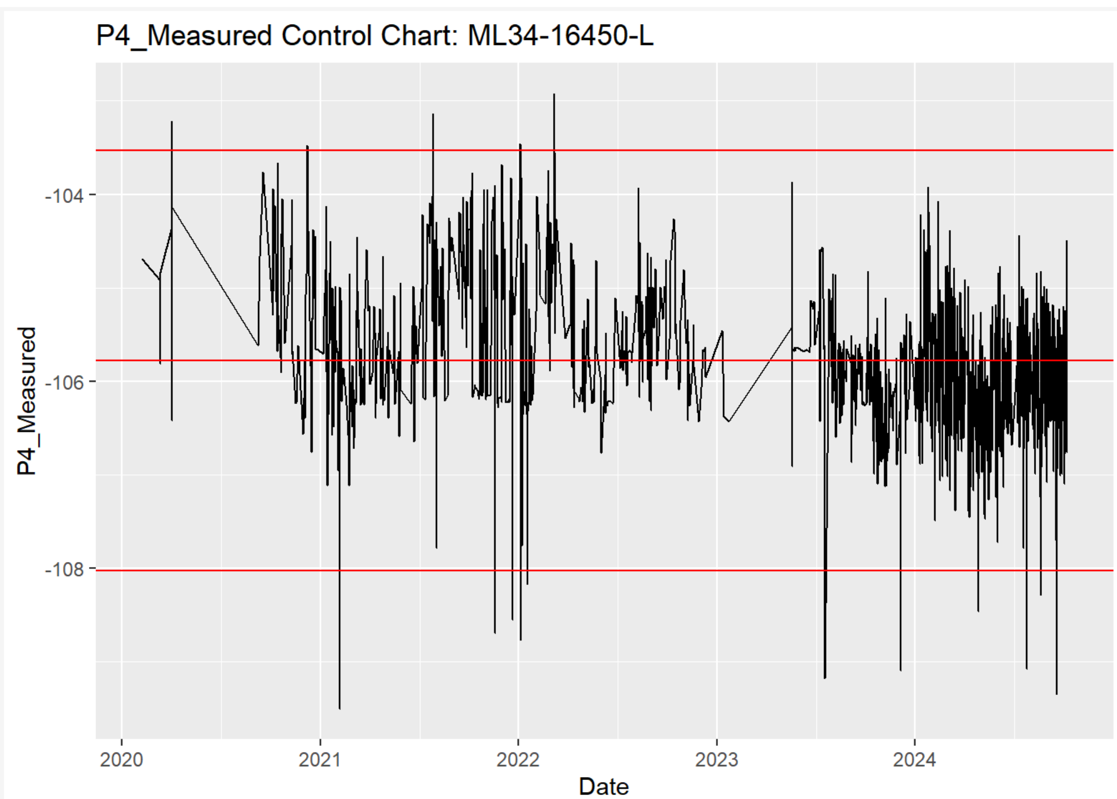
Different with outliers (3,4,6,9,10,12,13,16); Good trajectory (5,7,9,10,14)

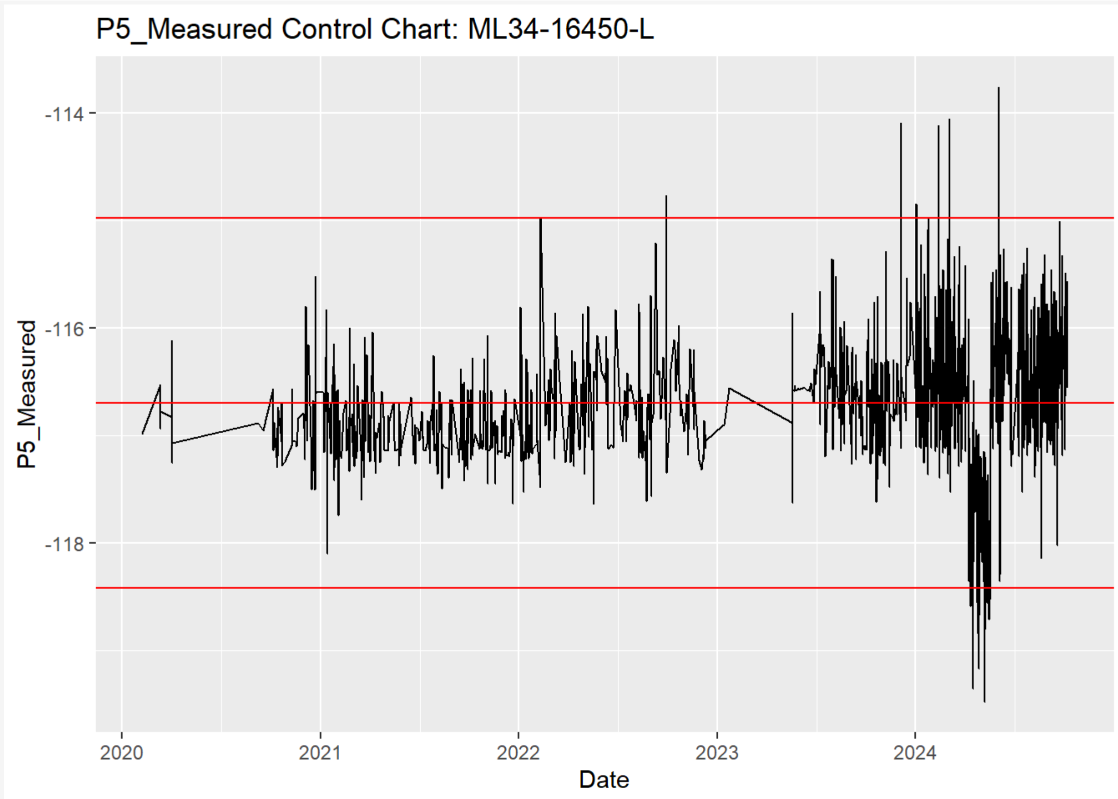
All 44 (22 features x 2 parts) Retrospective Control Charts with Six Sigma Limits

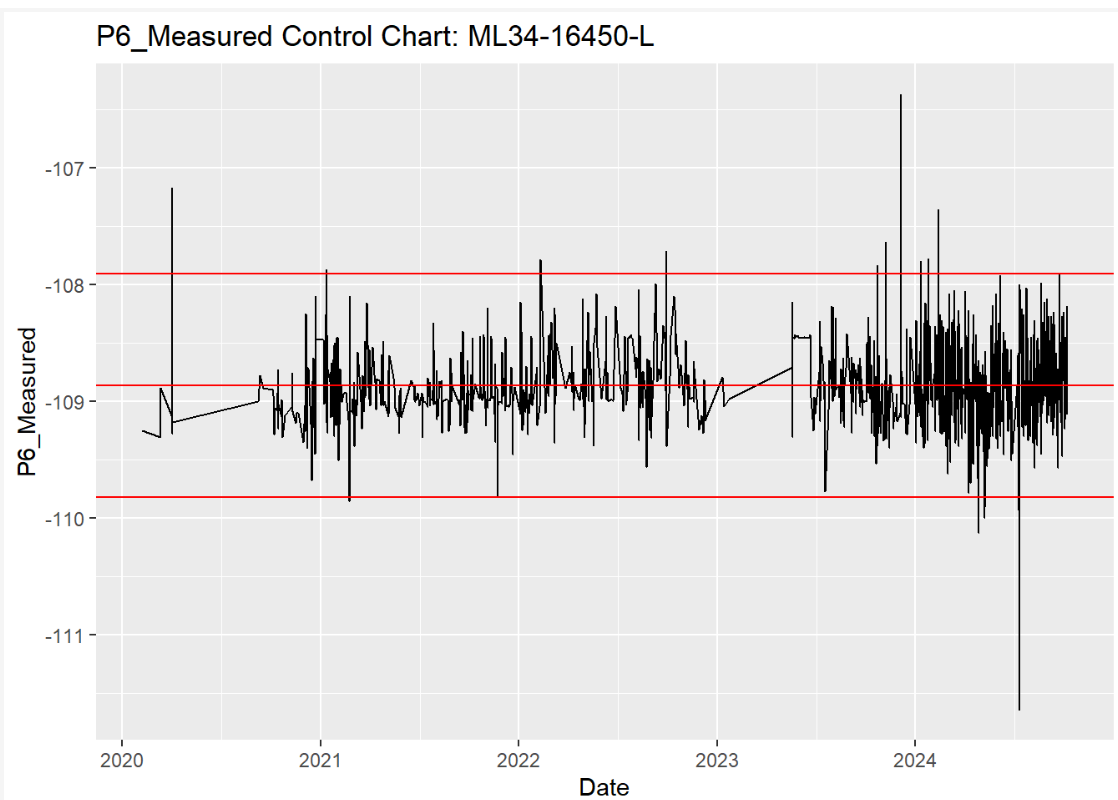


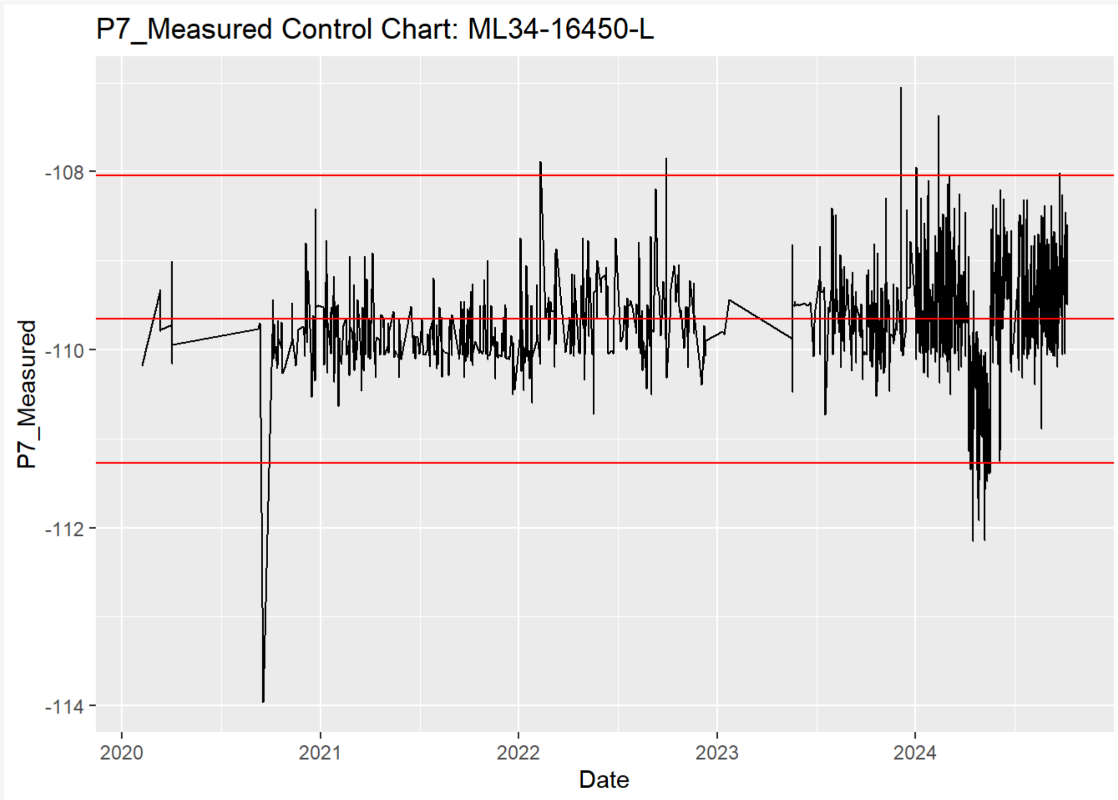


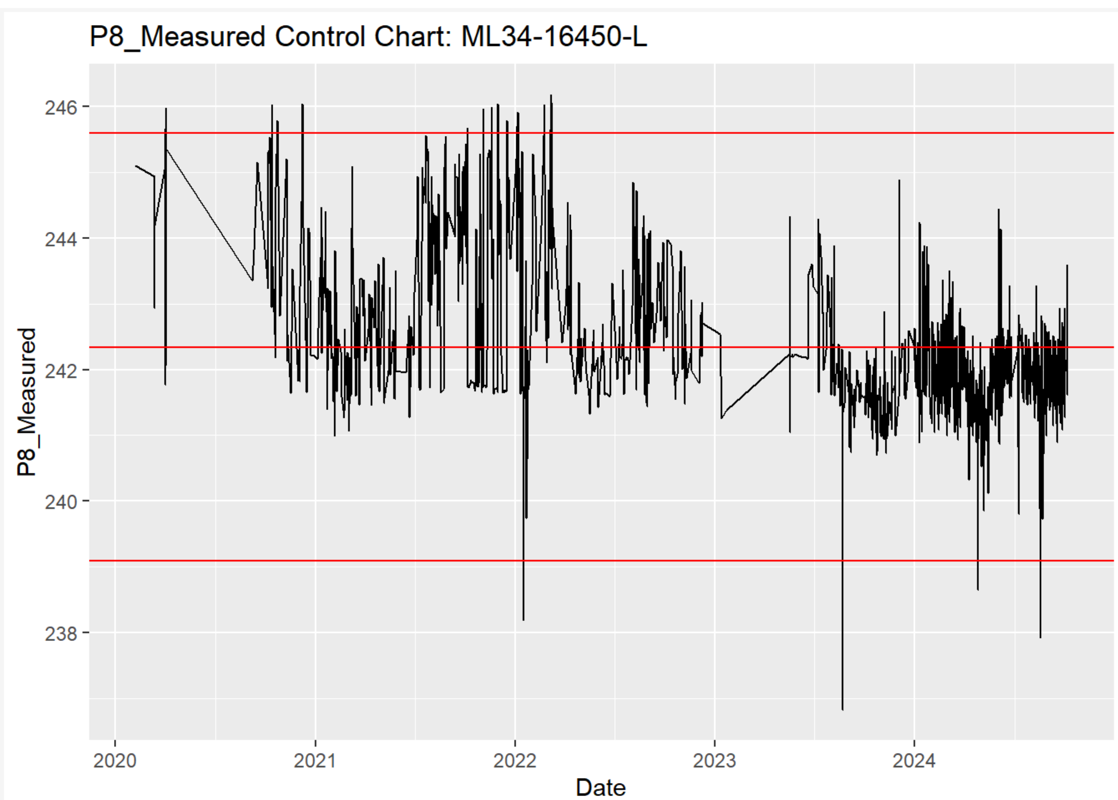

P3_Measured Control Chart: ML34-16450-L
P3_Measured
-108
-110
-112
2020
2021
2022
2023
2024
Date

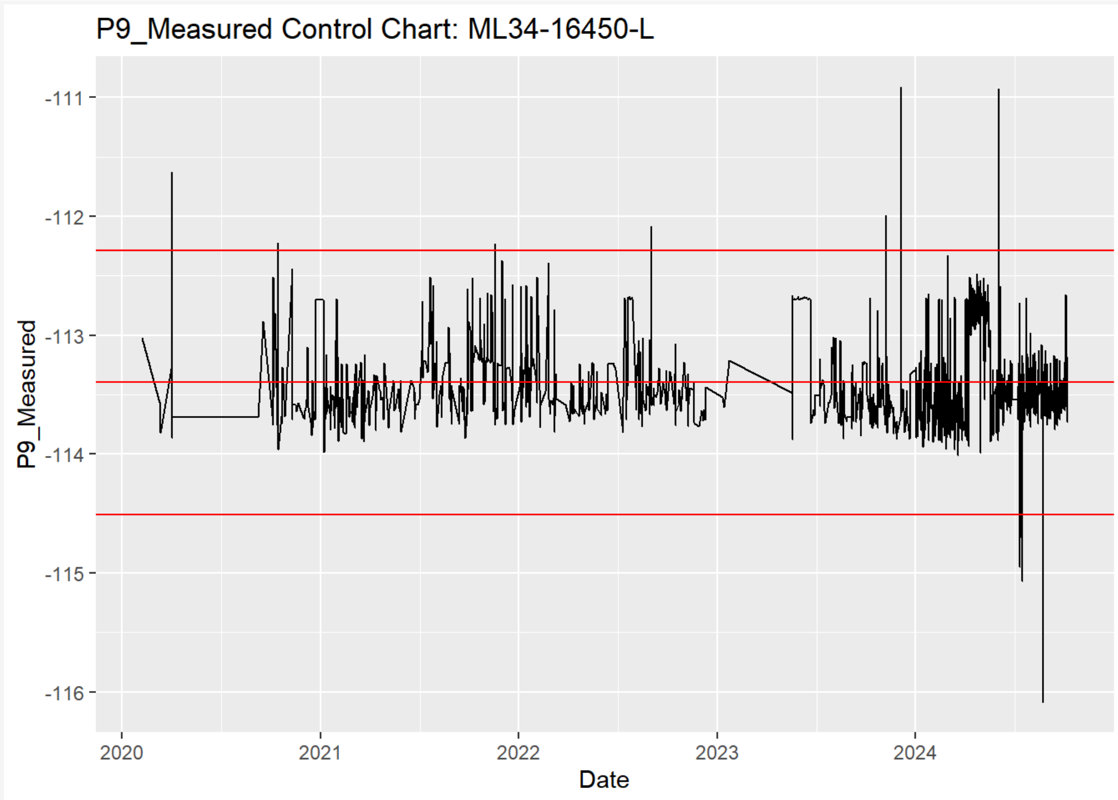

P4_Measured Control Chart: ML34-16450-L
P4_Measured
-104
-106
-108
2020
2021
2022
2023
2024
Date

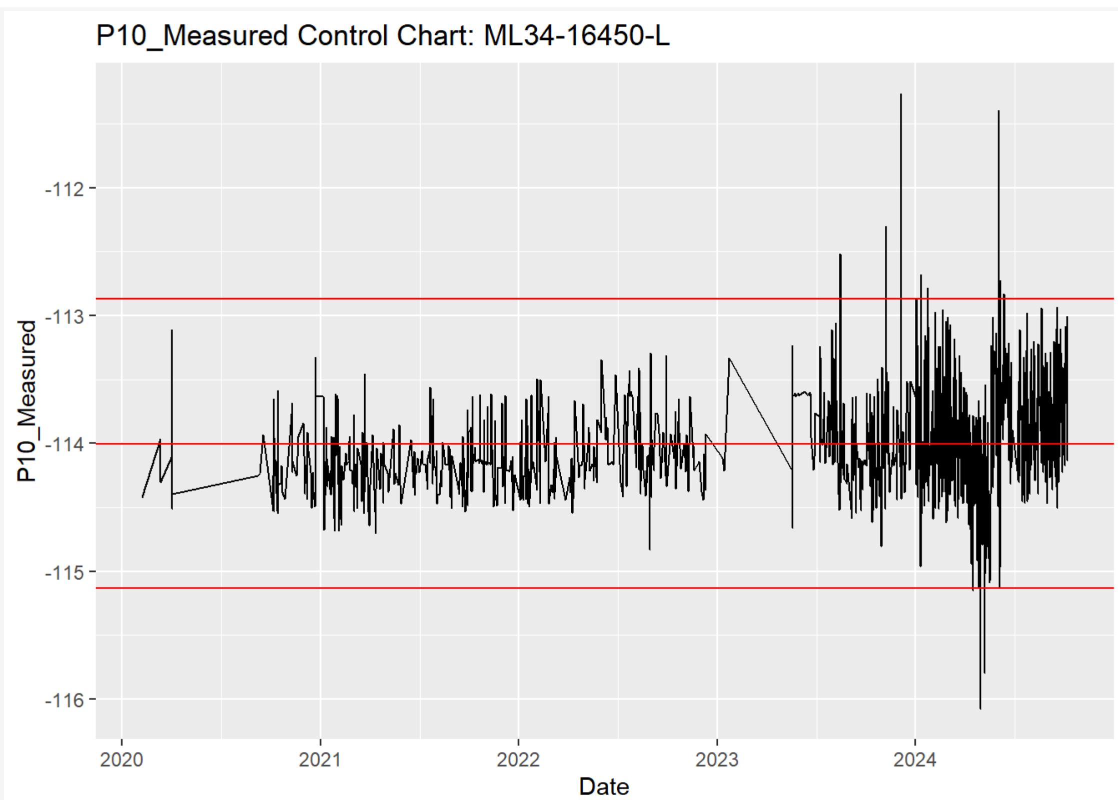

P5_Measured Control Chart: ML34-16450-L
P5_Measured
-114
-116
-118
2020
2021
2022
2023
2024
Date

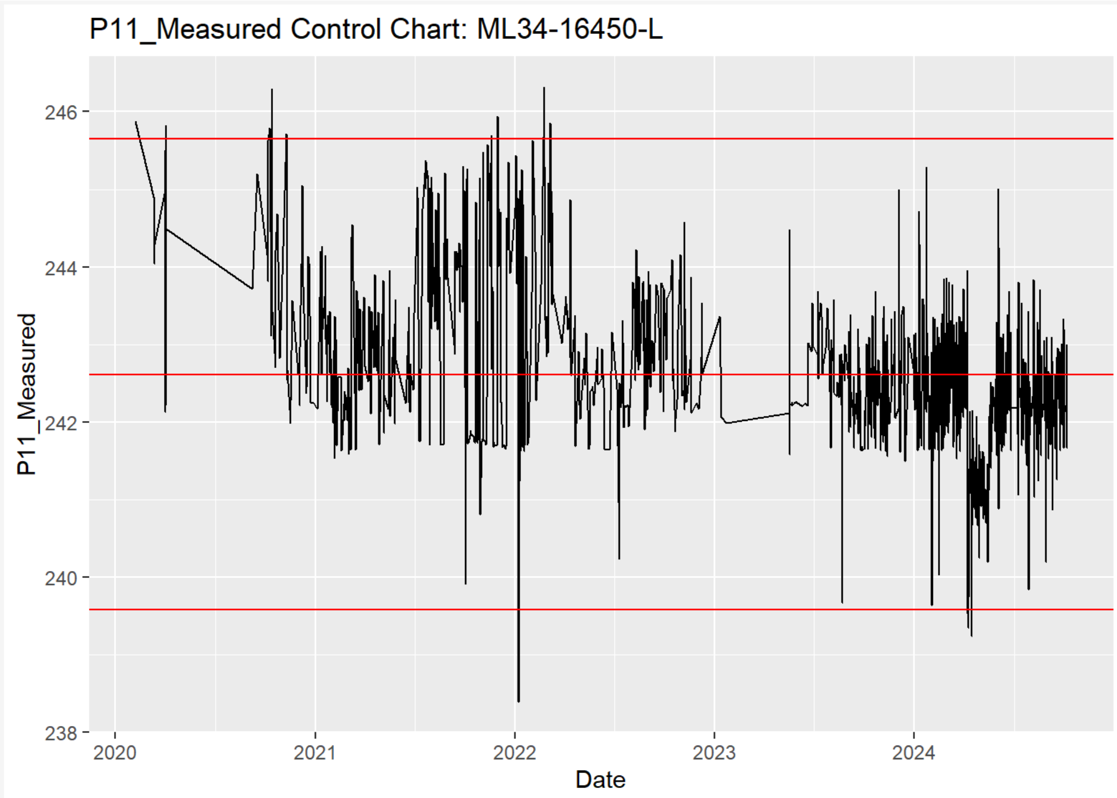

P6_Measured Control Chart: ML34-16450-L
P6_Measured
-107
-108
-109
-110
-111
2020
2021
2022
2023
2024
Date


P7_Measured Control Chart: ML34-16450-L
P7_Measured
-108
-110
-112
-114
2020
2021
2022
2023
2024
Date

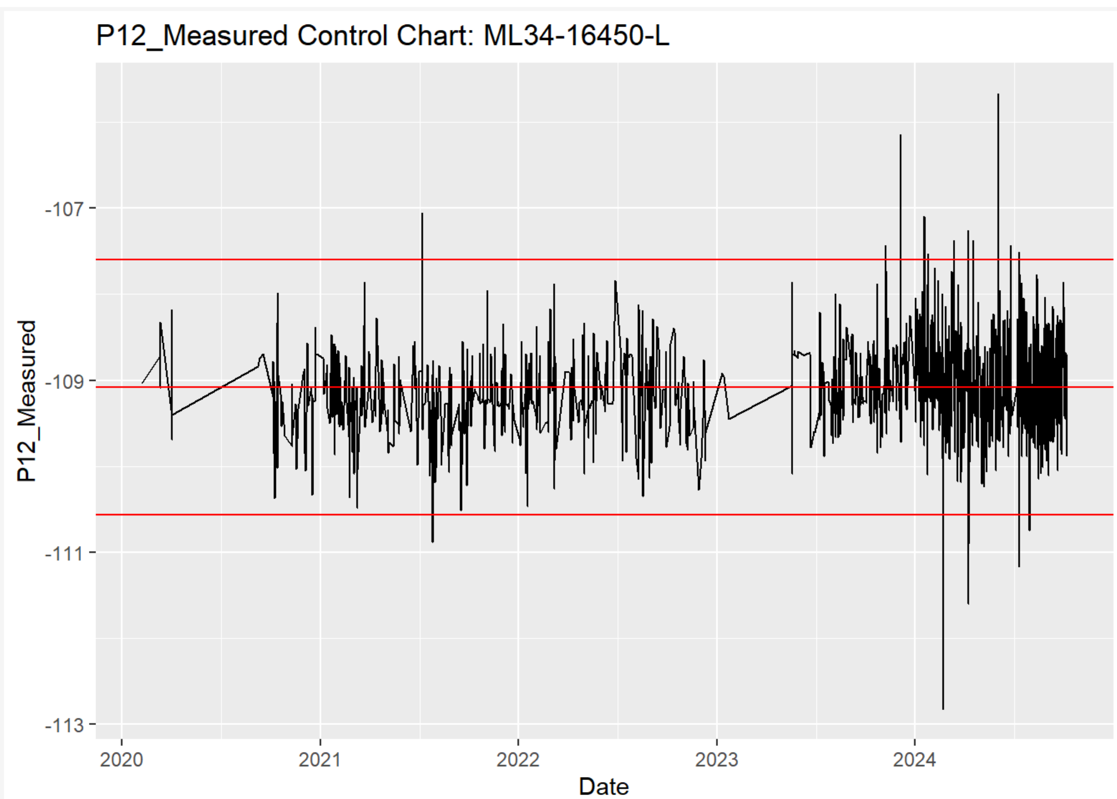

P8_Measured Control Chart: ML34-16450-L
P8_Measured
246
244
242
240
238
2020
2021
2022
2023
2024
Date


P9_Measured Control Chart: ML34-16450-L
P9_Measured
-111
-112
-113
-114
-115
-116
2020
2021
2022
2023
2024
Date

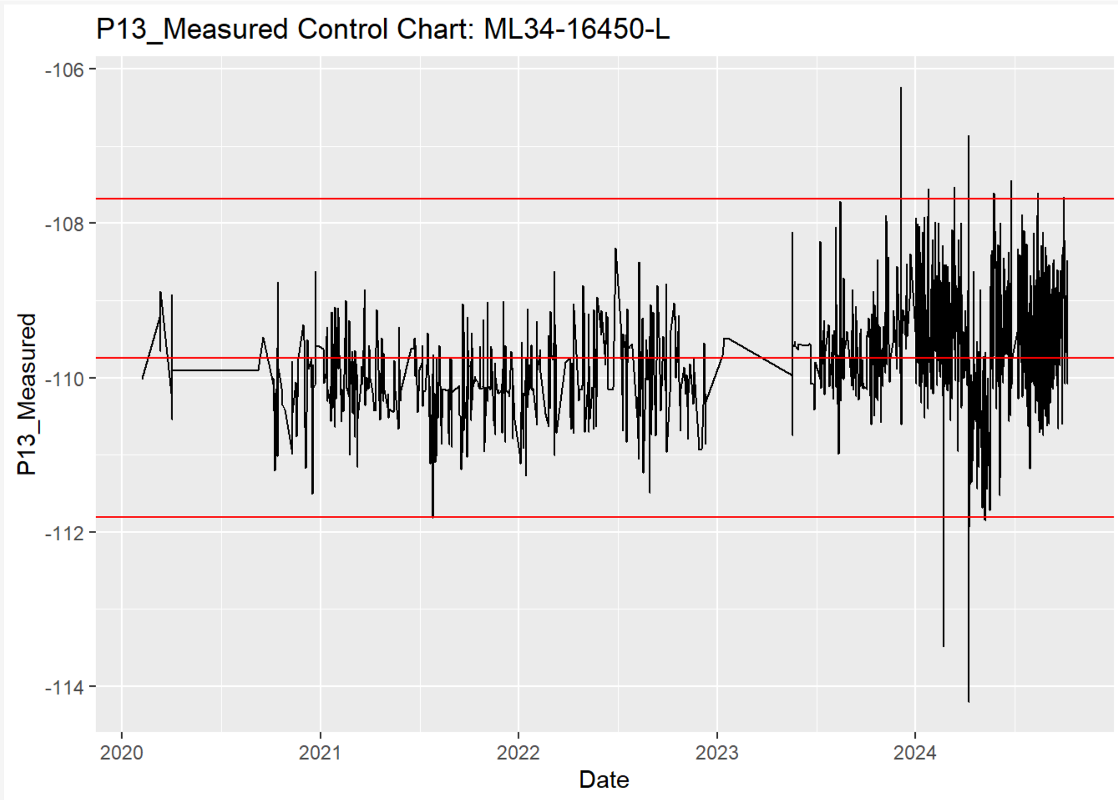

P10_Measured Control Chart: ML34-16450-L
P10_Measured
-112
-113
-114
-115
-116
2020
2021
2022
2023
2024
Date

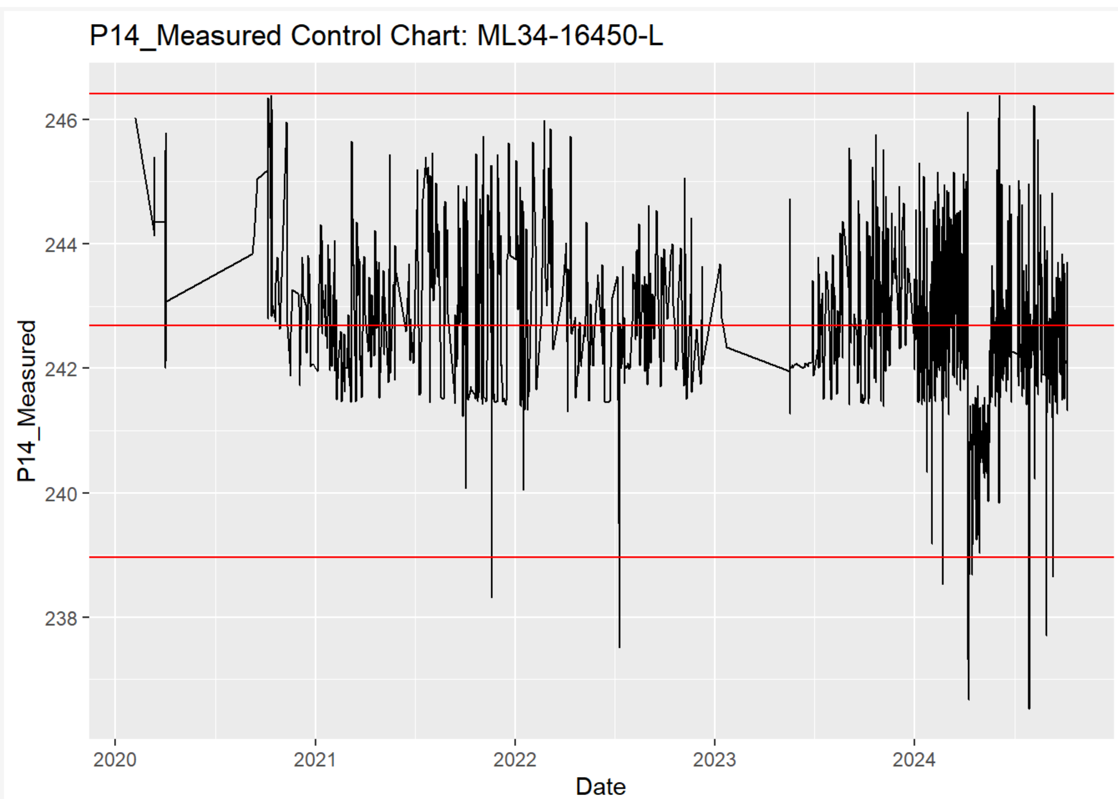


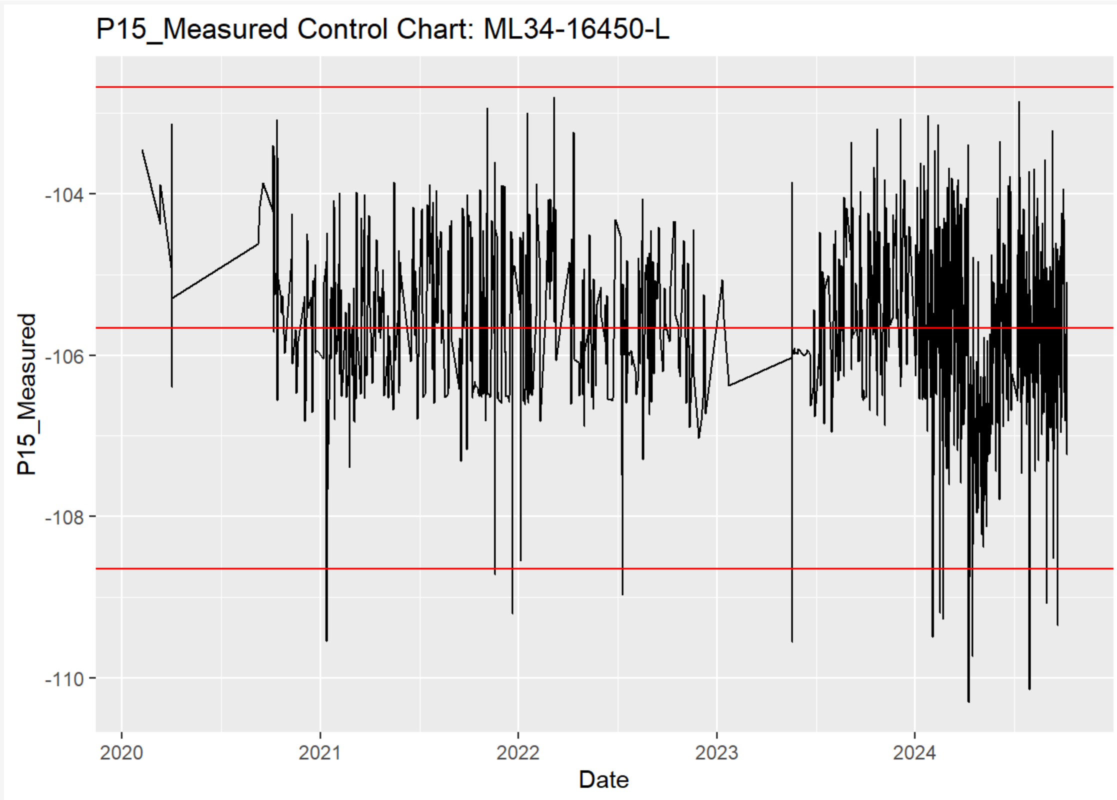
P11_Measured Control Chart: ML34-16450-L
P11_Measured
246
244
242
240
238
2020
2021
2022
2023
2024
Date



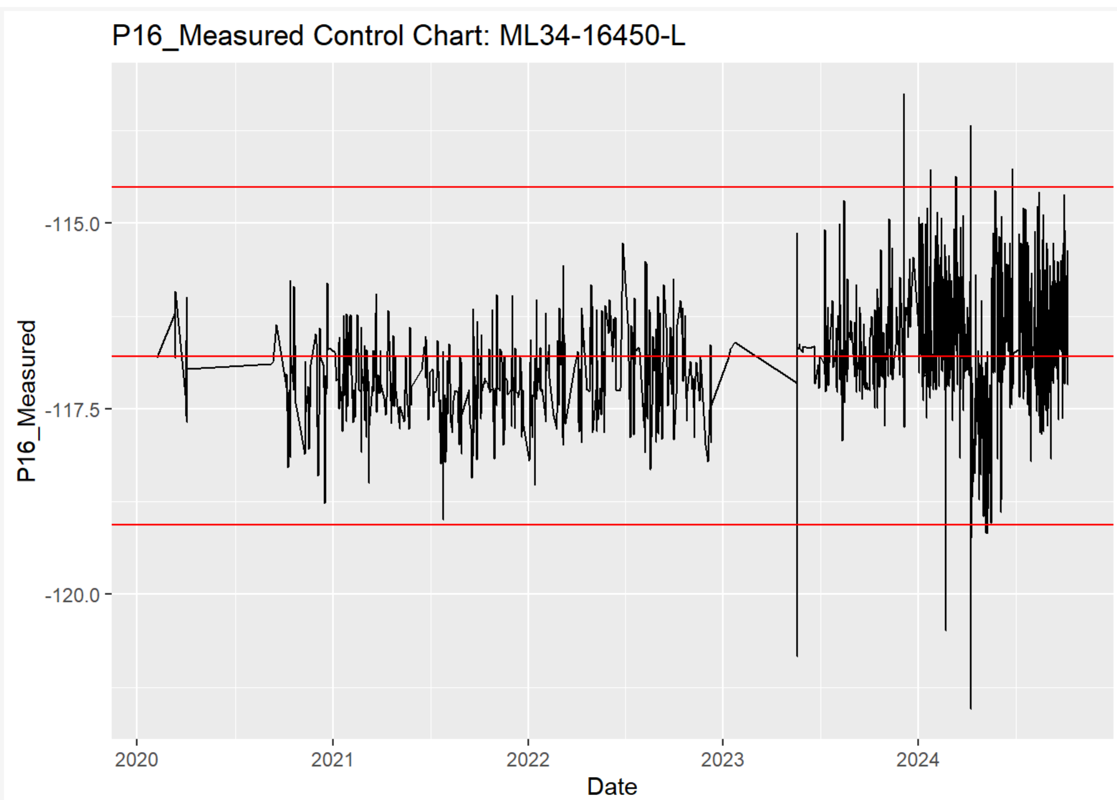
P12_Measured Control Chart: ML34-16450-L
P12_Measured
-107
-109
-111
-113
2020
2021
2022
2023
2024
Date


P13_Measured Control Chart: ML34-16450-L
-106
-108
-110
-112
-114
P13_Measured
2020
2021
2022
2023
2024
Date

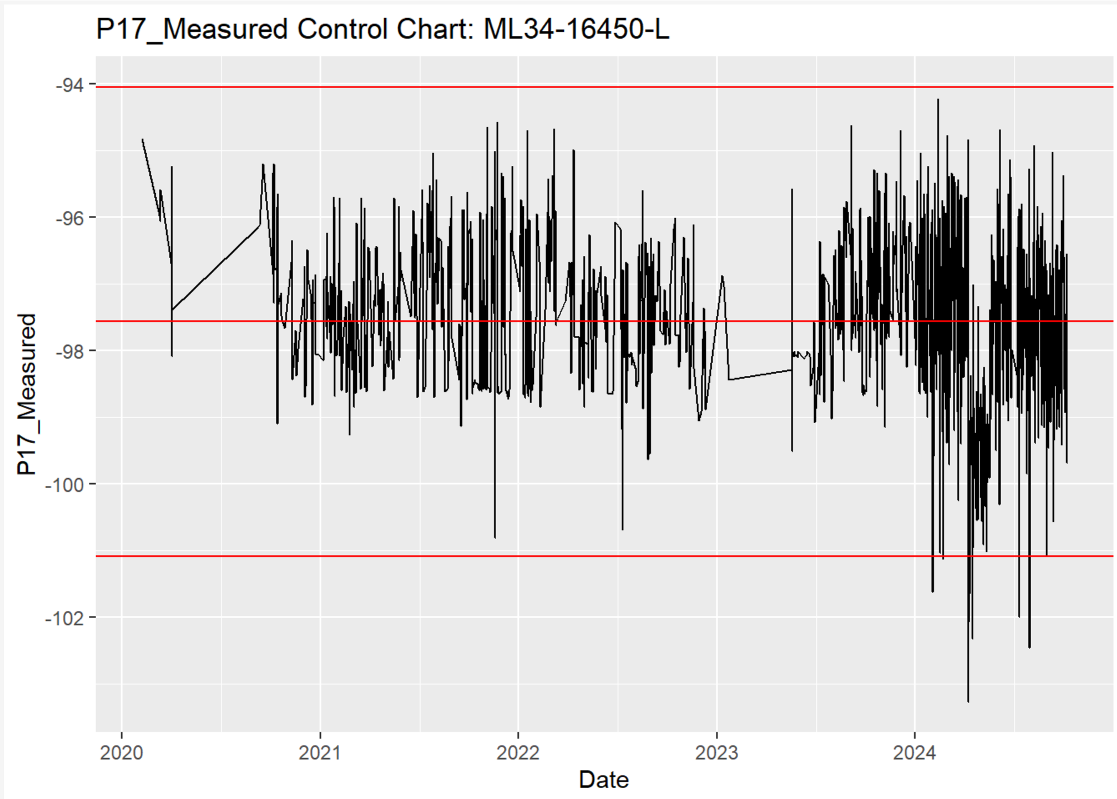

P14_Measured Control Chart: ML34-16450-L
246
244
242
240
238
P14_Measured
2020
2021
2022
2023
2024
Date

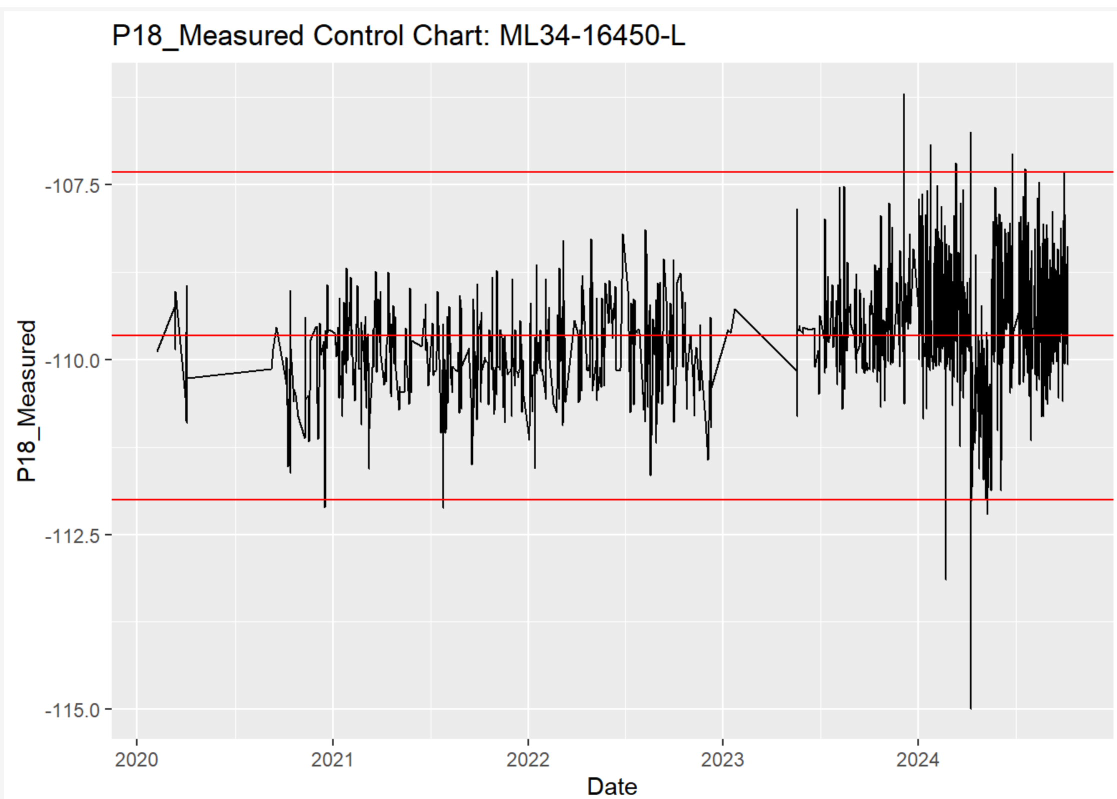


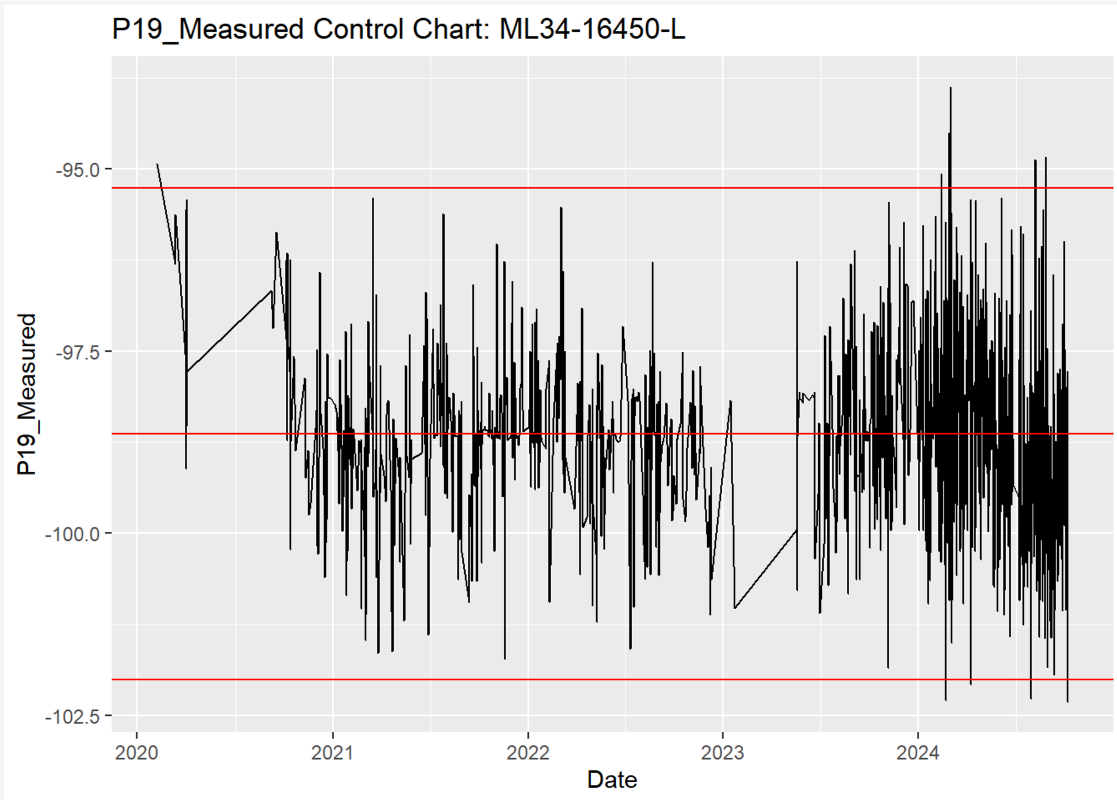
P15_Measured Control Chart: ML34-16450-L
P15_Measured
-104
-106
-108
-110
2020
2021
2022
2023
2024
Date

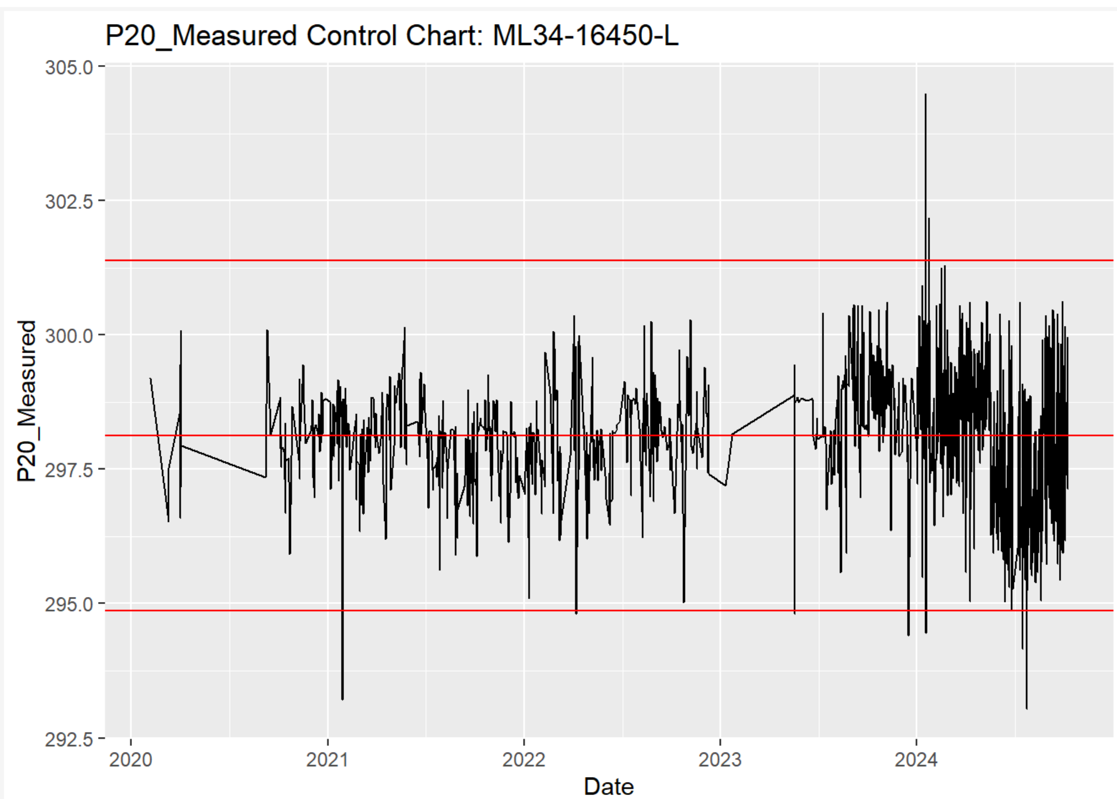


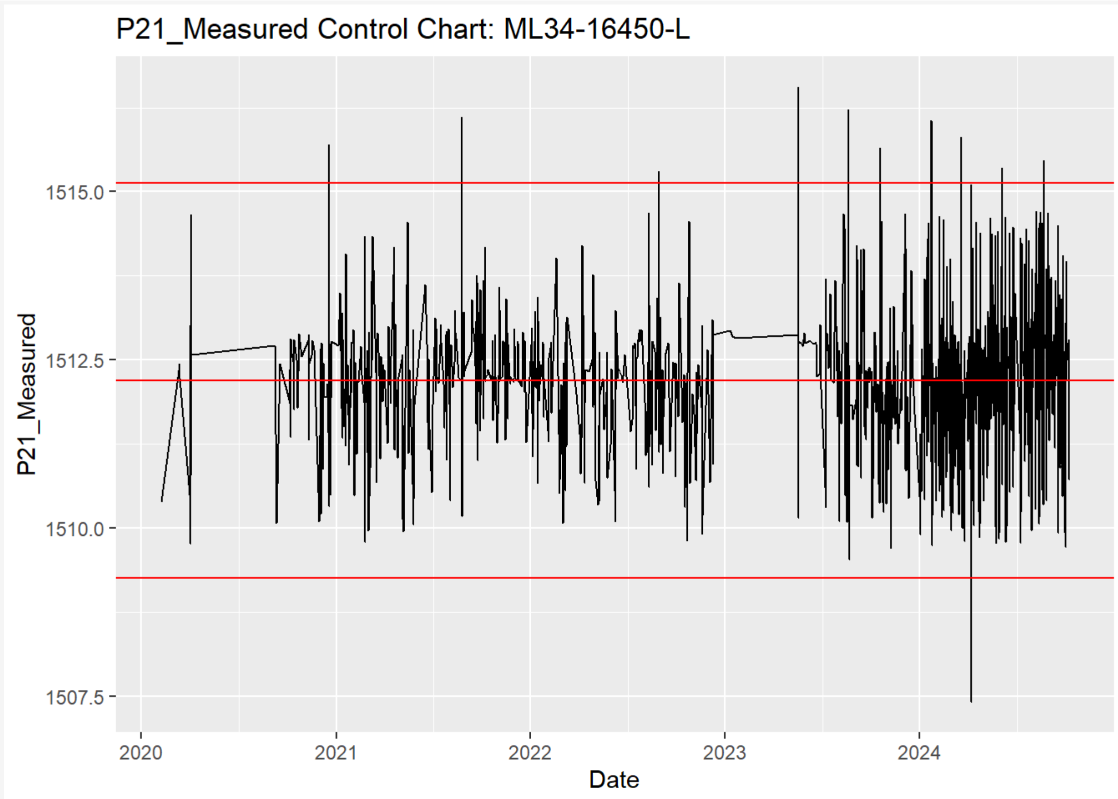
P16_Measured Control Chart: ML34-16450-L
P16_Measured
-115.0
-117.5
-120.0
2020
2021
2022
2023
2024
Date

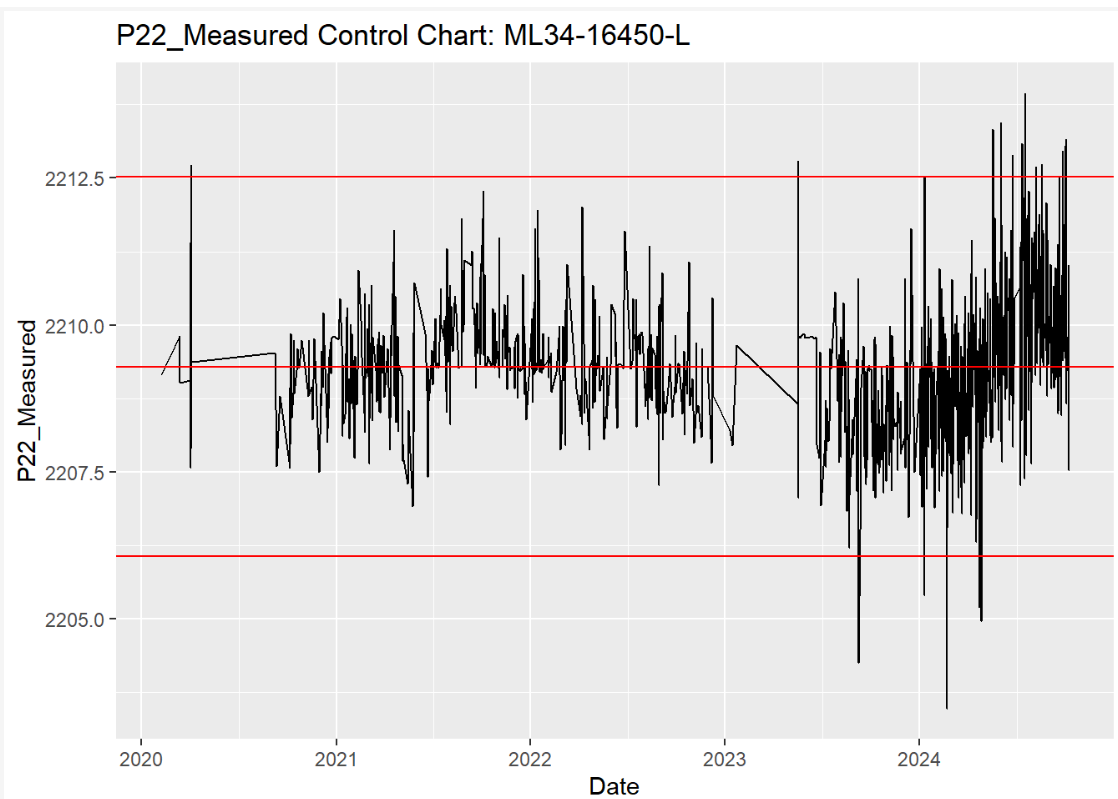

P17_Measured Control Chart: ML34-16450-L
P17_Measured
-94
-96
-98
-100
-102
2020
2021
2022
2023
2024
Date

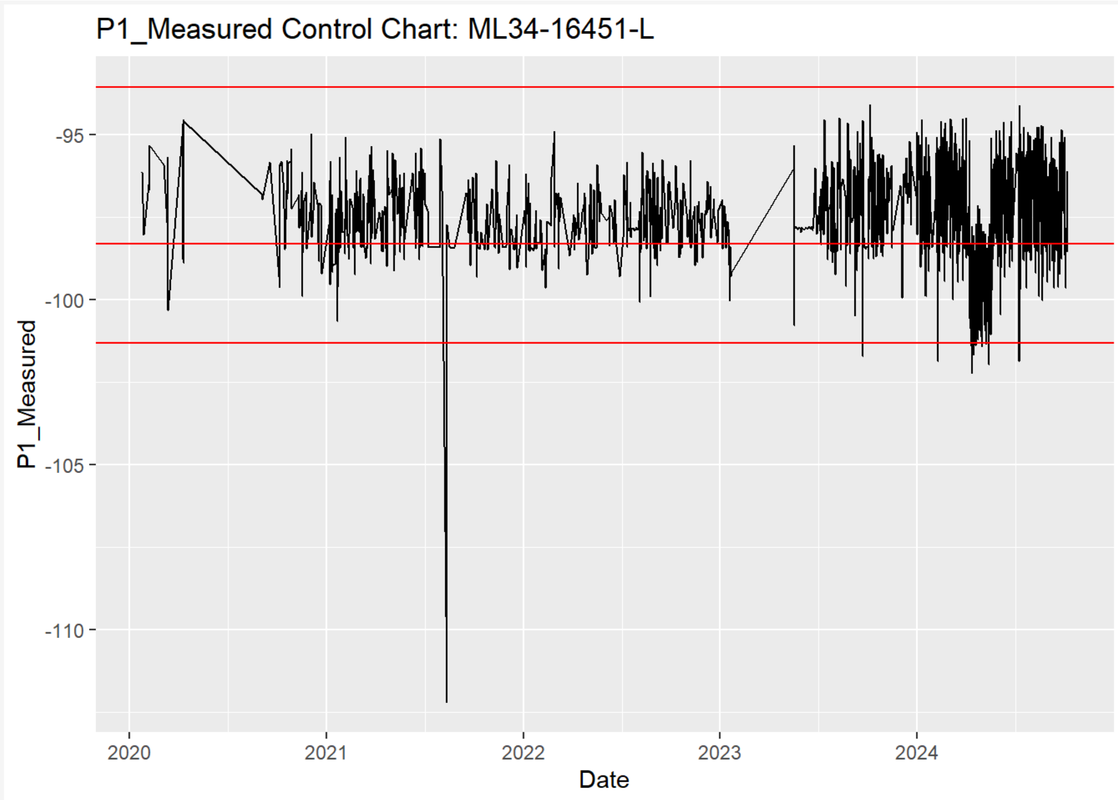

P18_Measured Control Chart: ML34-16450-L
P18_Measured
-107.5
-110.0
-112.5
-115.0
2020
2021
2022
2023
2024
Date

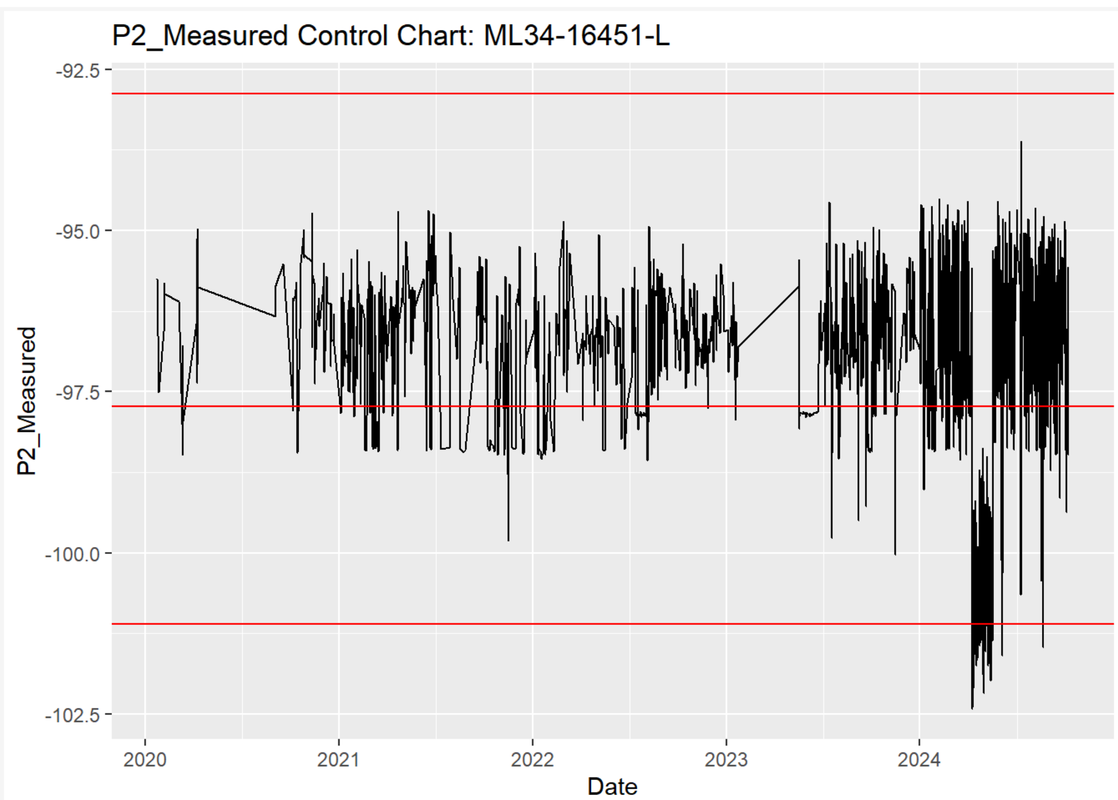

P19_Measured Control Chart: ML34-16450-L
P19_Measured
-95.0
-97.5
-100.0
-102.5
2020
2021
2022
2023
2024
Date

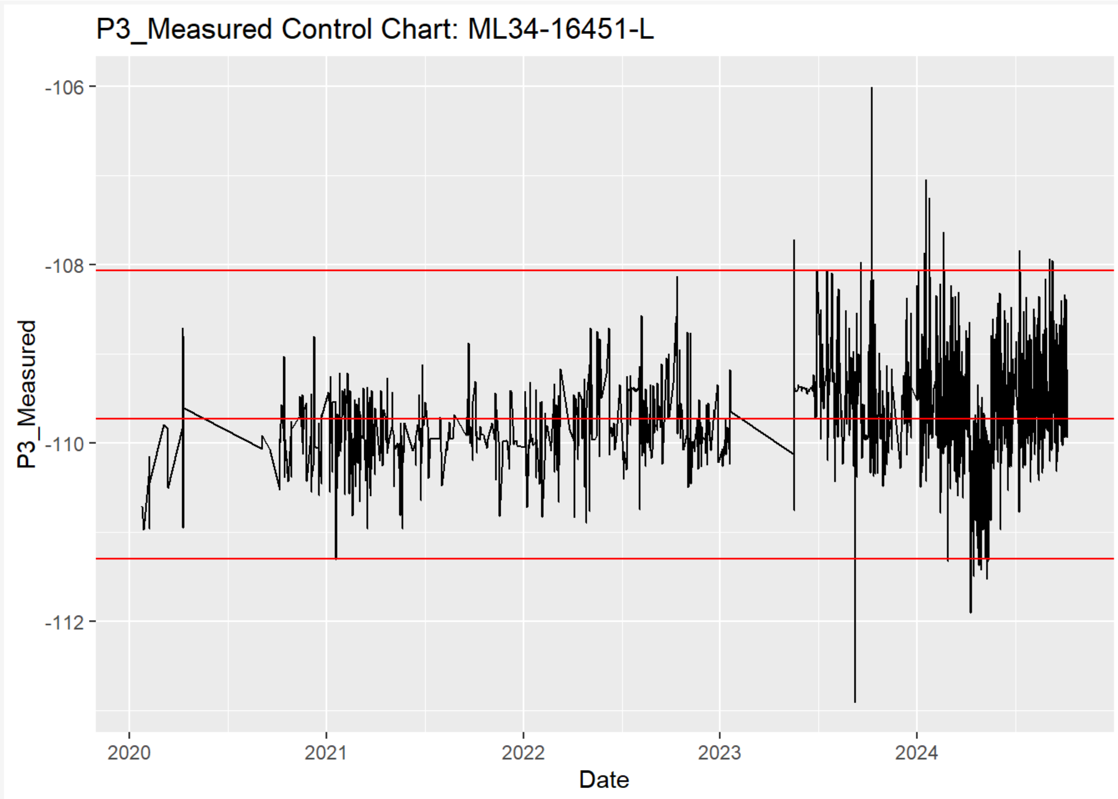

P20_Measured Control Chart: ML34-16450-L
P20_Measured
305.0
302.5
300.0
297.5
295.0
292.5
2020
2021
2022
2023
2024
Date


P21_Measured Control Chart: ML34-16450-L
P21_Measured
1515.0
1512.5
1510.0
1507.5
2020
2021
2022
2023
2024
Date

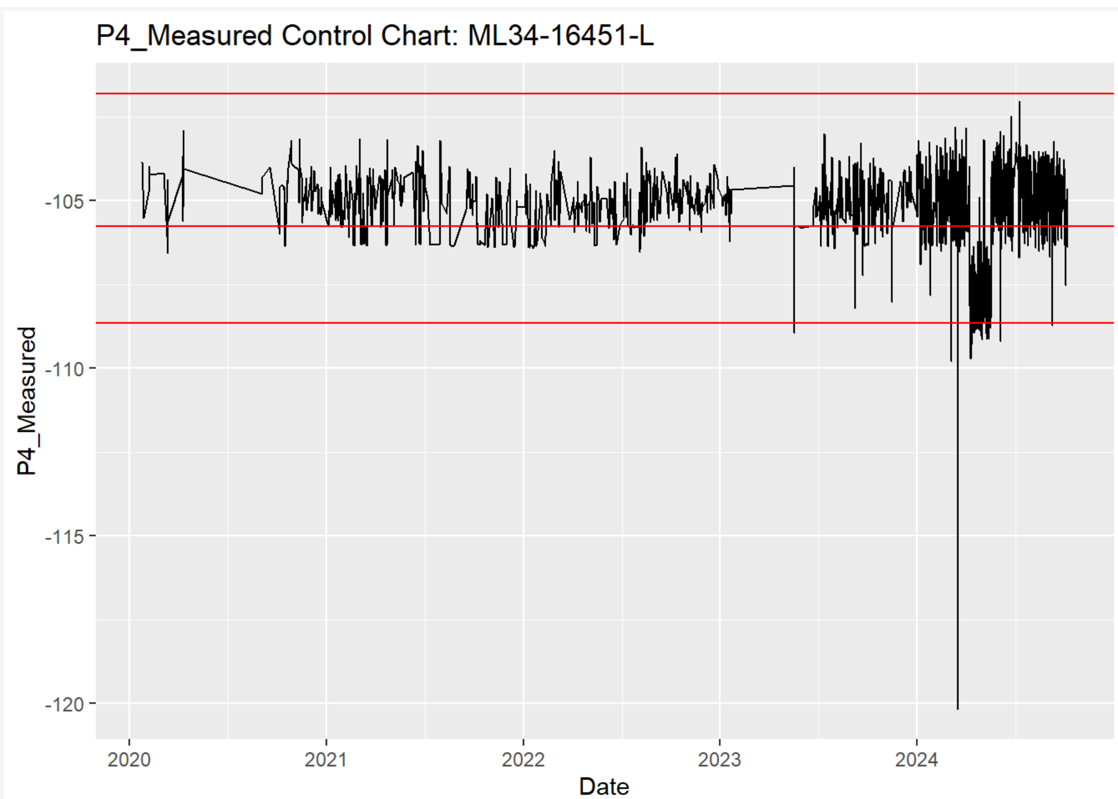

P22_Measured Control Chart: ML34-16450-L
P22_Measured
2212.5
2210.0
2207.5
2205.0
2020
2021
2022
2023
2024
Date


P1_Measured Control Chart: ML34-16451-L
-95
-100
-105
-110
P1_Measured
2020
2021
2022
2023
2024
Date

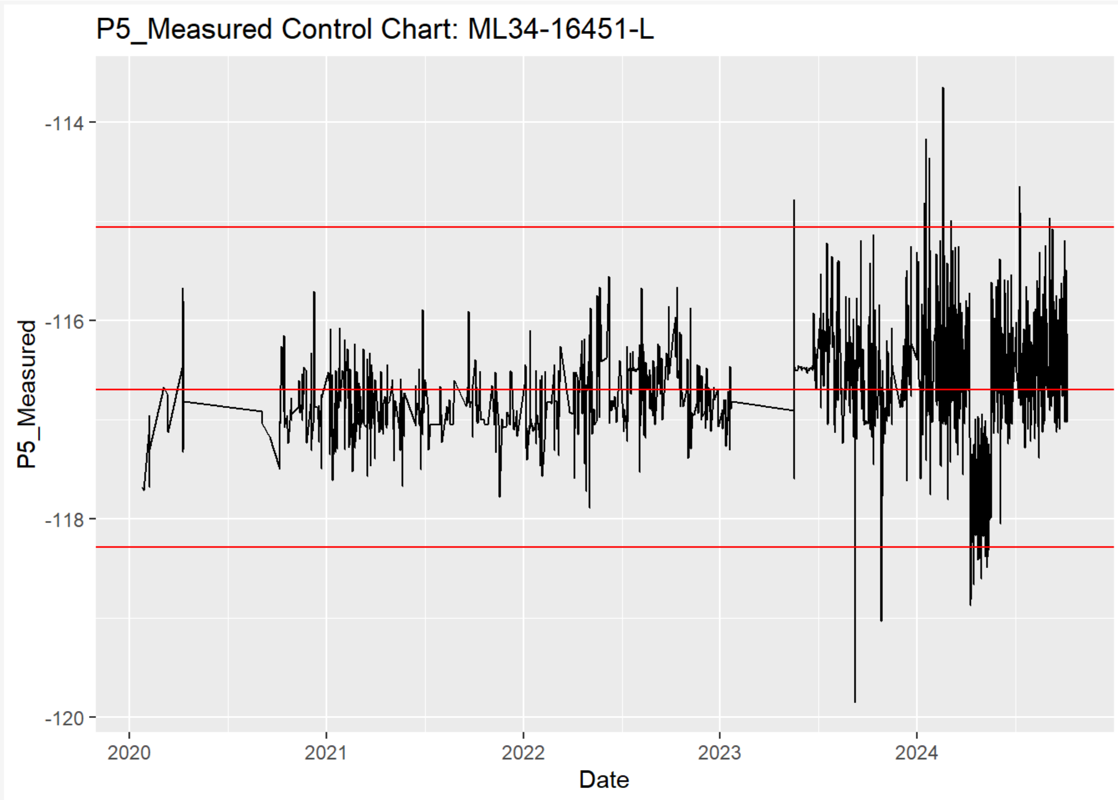

P2_Measured Control Chart: ML34-16451-L
-92.5
-95.0
-97.5
-100.0
-102.5
P2_Measured
2020
2021
2022
2023
2024
Date

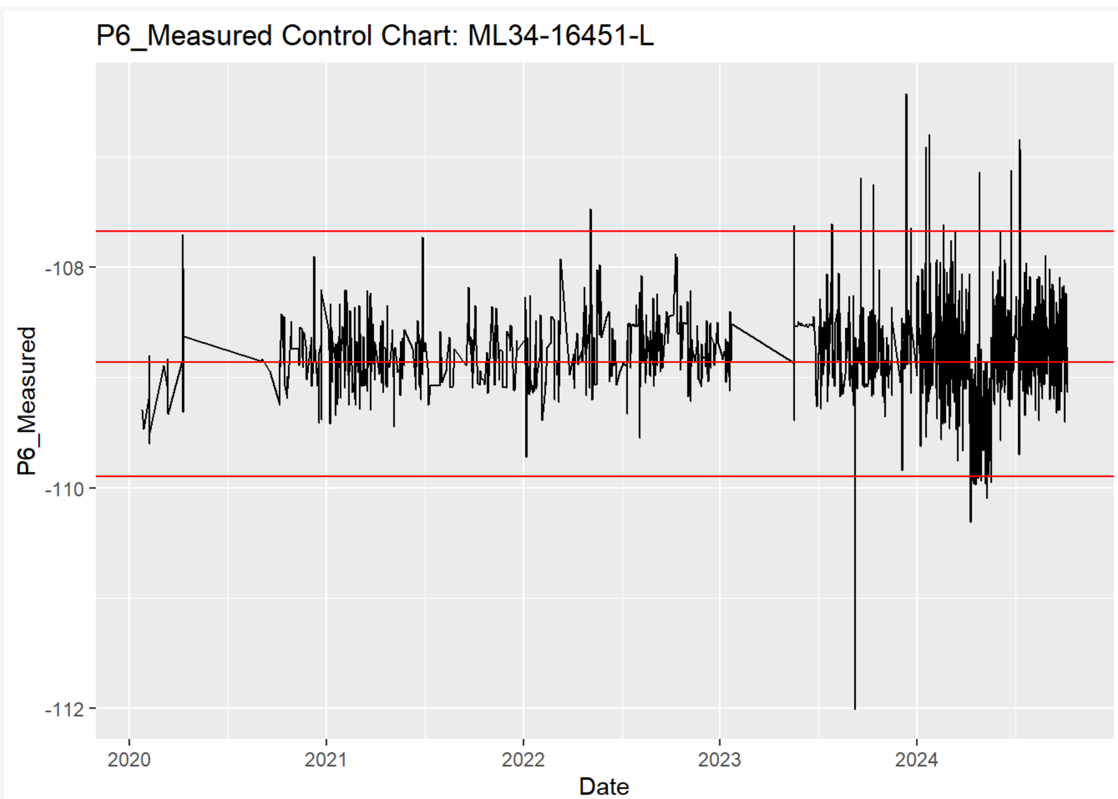


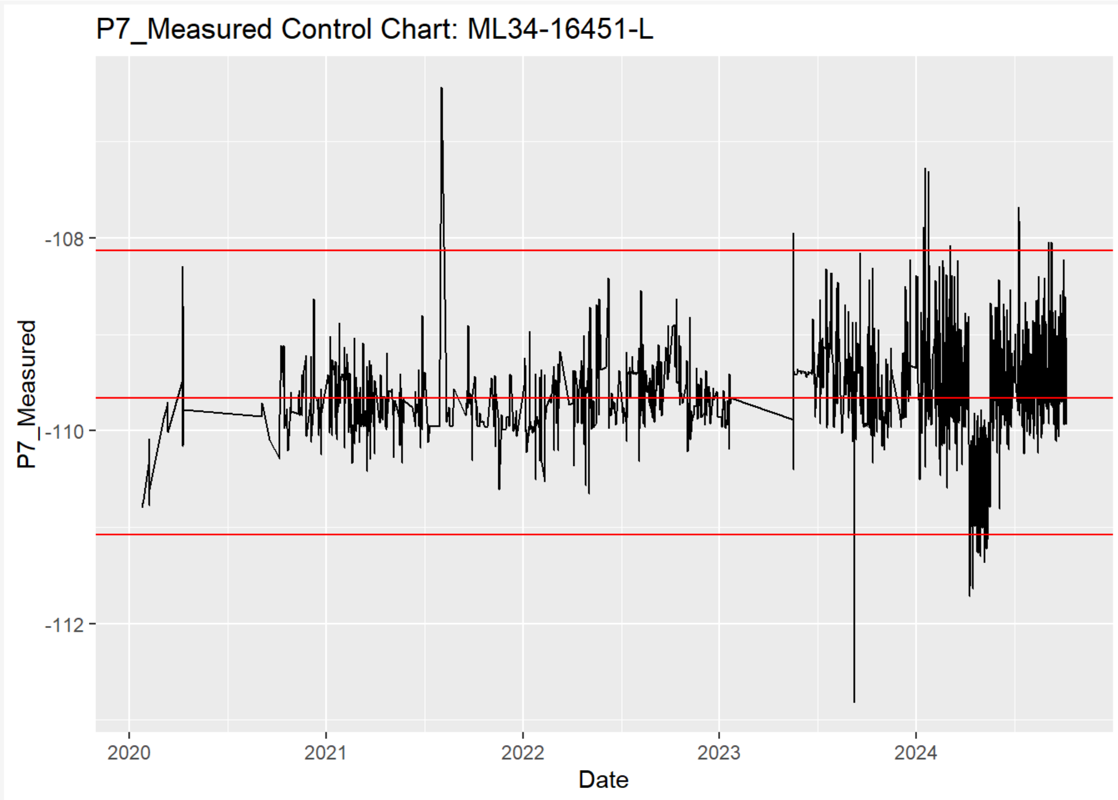
P3_Measured Control Chart: ML34-16451-L
-106
-108
-110
-112
P3_Measured
2020
2021
2022
2023
2024
Date

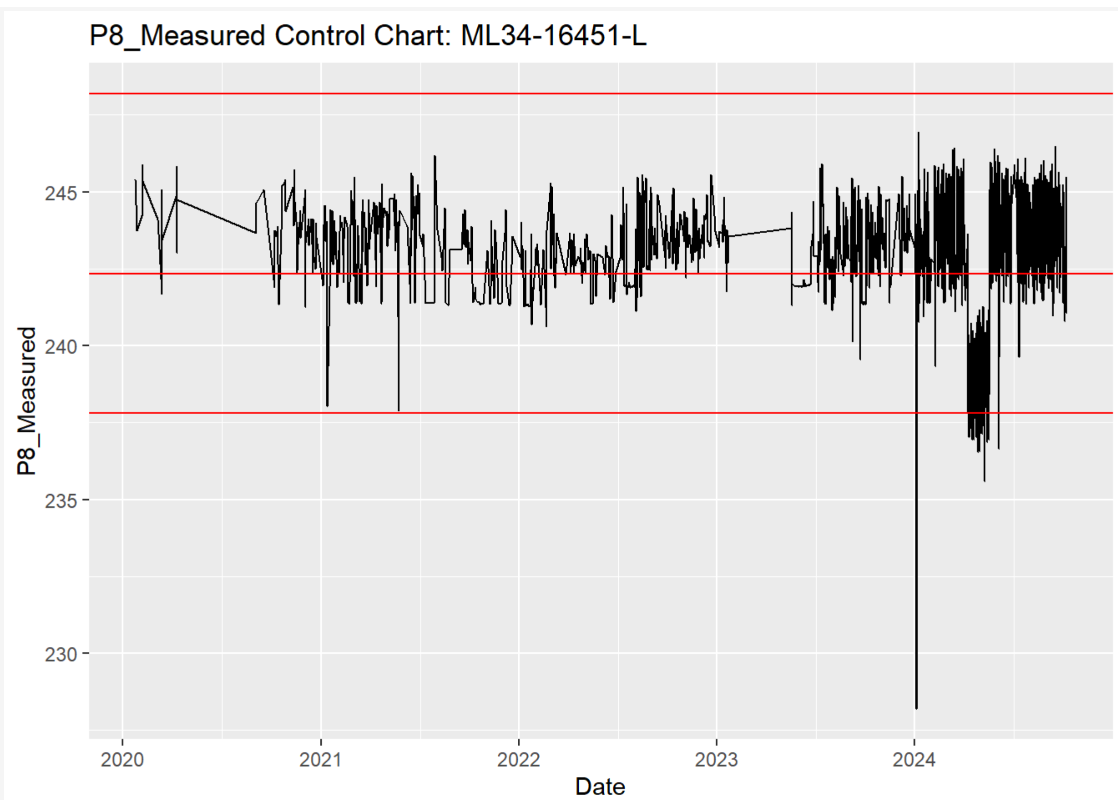


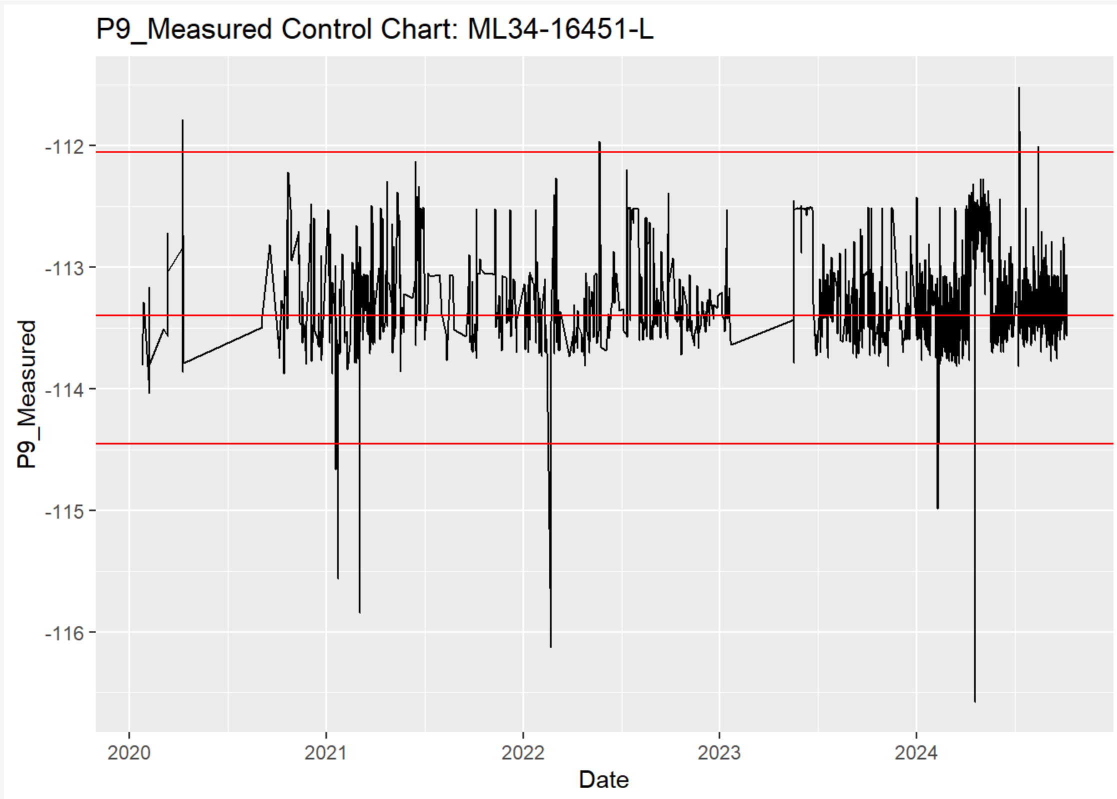
P4_Measured Control Chart: ML34-16451-L
-105
-110
-115
-120
P4_Measured
2020
2021
2022
2023
2024
Date

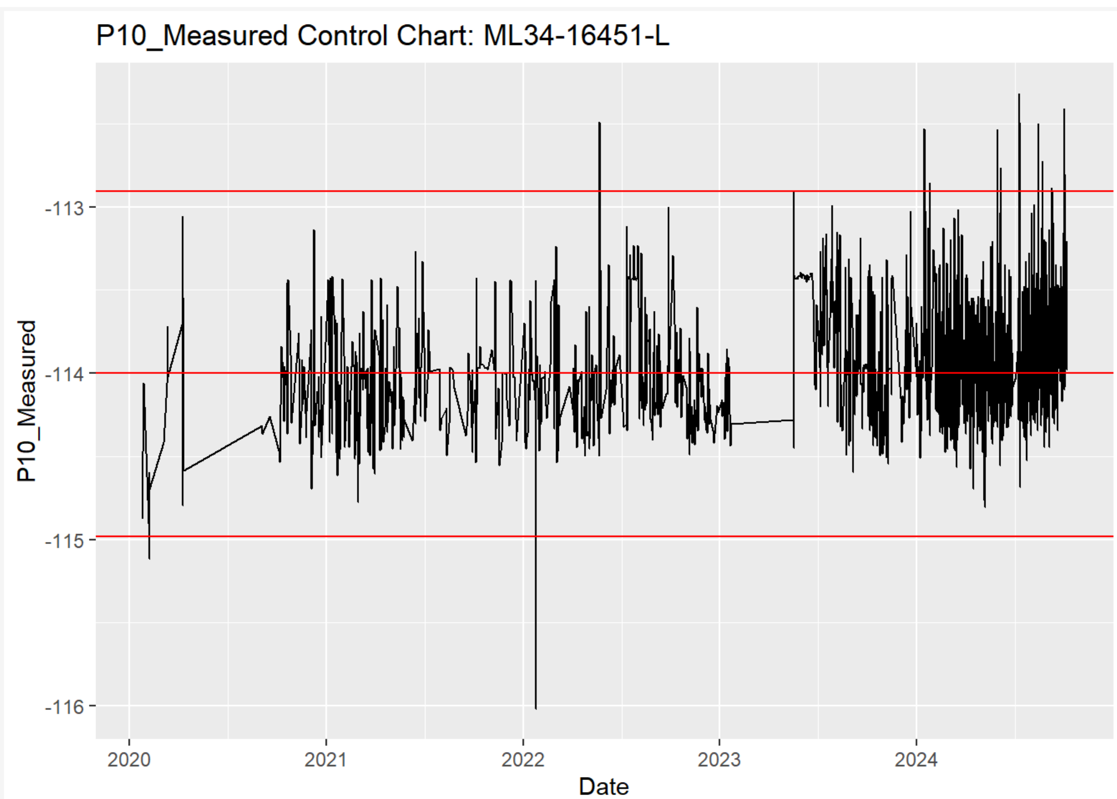

P5_Measured Control Chart: ML34-16451-L
P5_Measured
-114
-116
-118
-120
2020
2021
2022
2023
2024
Date

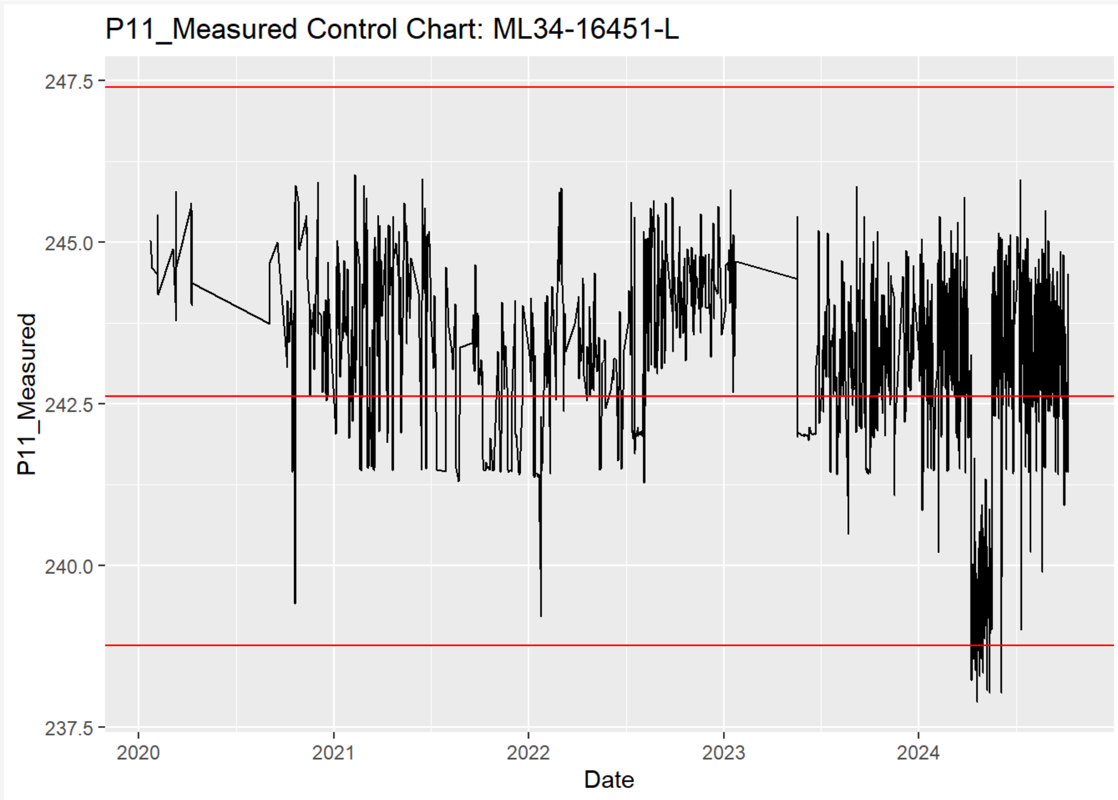

P6_Measured Control Chart: ML34-16451-L
P6_Measured
-108
-110
-112
2020
2021
2022
2023
2024
Date

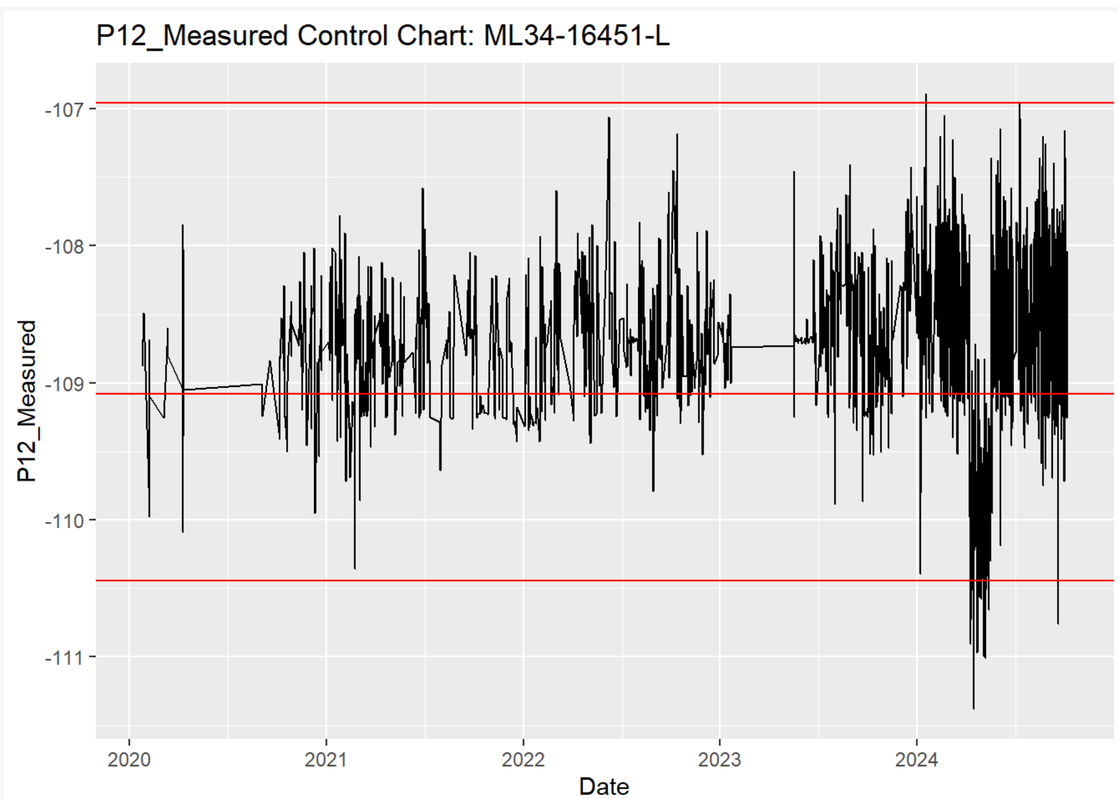

P7_Measured Control Chart: ML34-16451-L
P7_Measured
-108
-110
-112
2020
2021
2022
2023
2024
Date

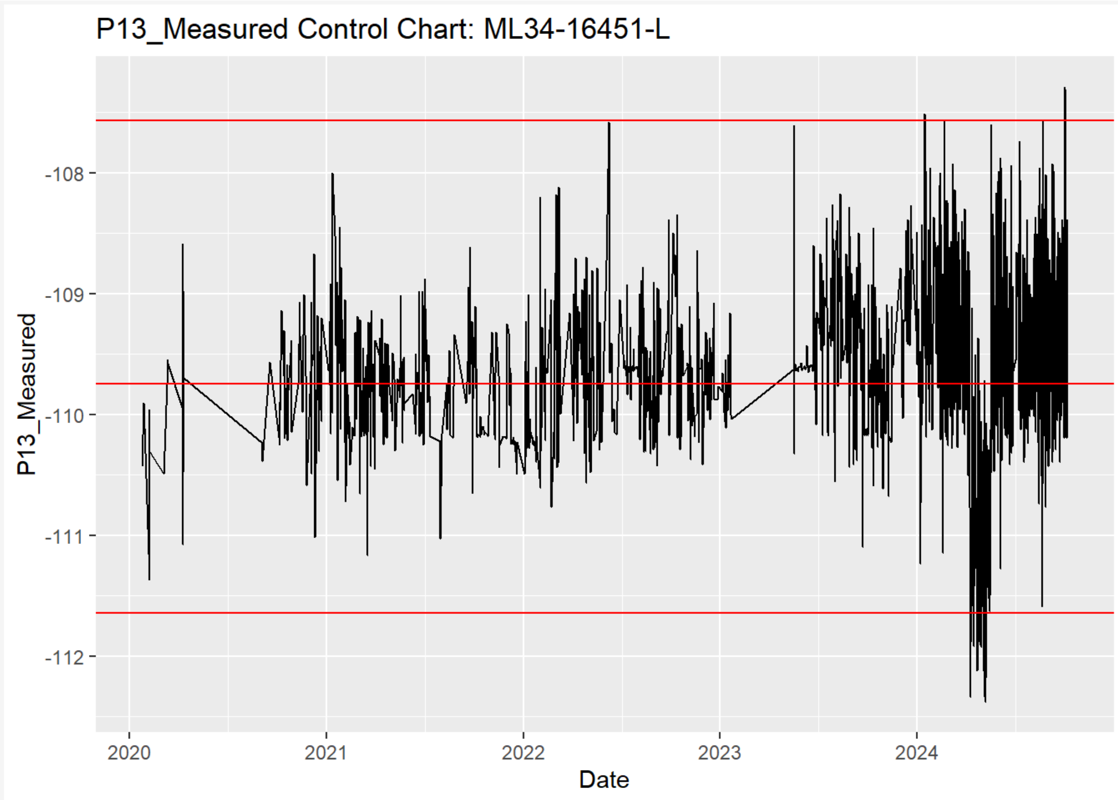

P8_Measured Control Chart: ML34-16451-L
P8_Measured
245
240
235
230
2020
2021
2022
2023
2024
Date

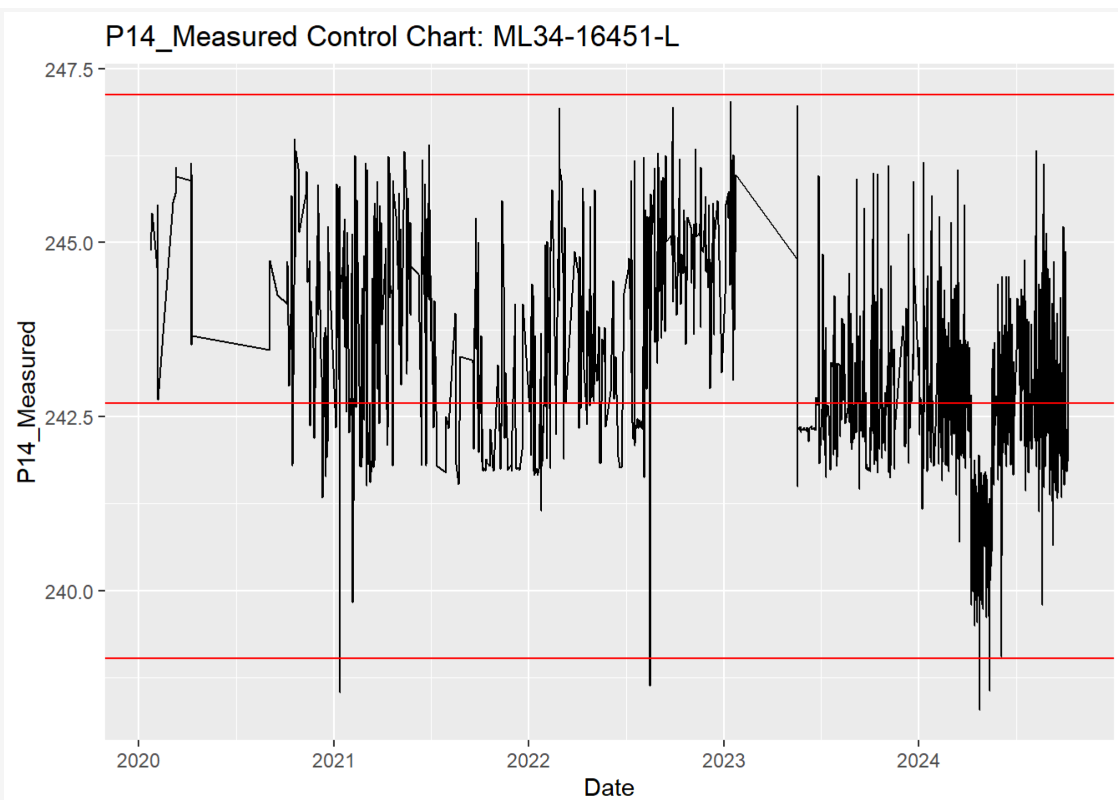

P9_Measured Control Chart: ML34-16451-L
P9_Measured
-112
-113
-114
-115
-116
2020
2021
2022
2023
2024
Date

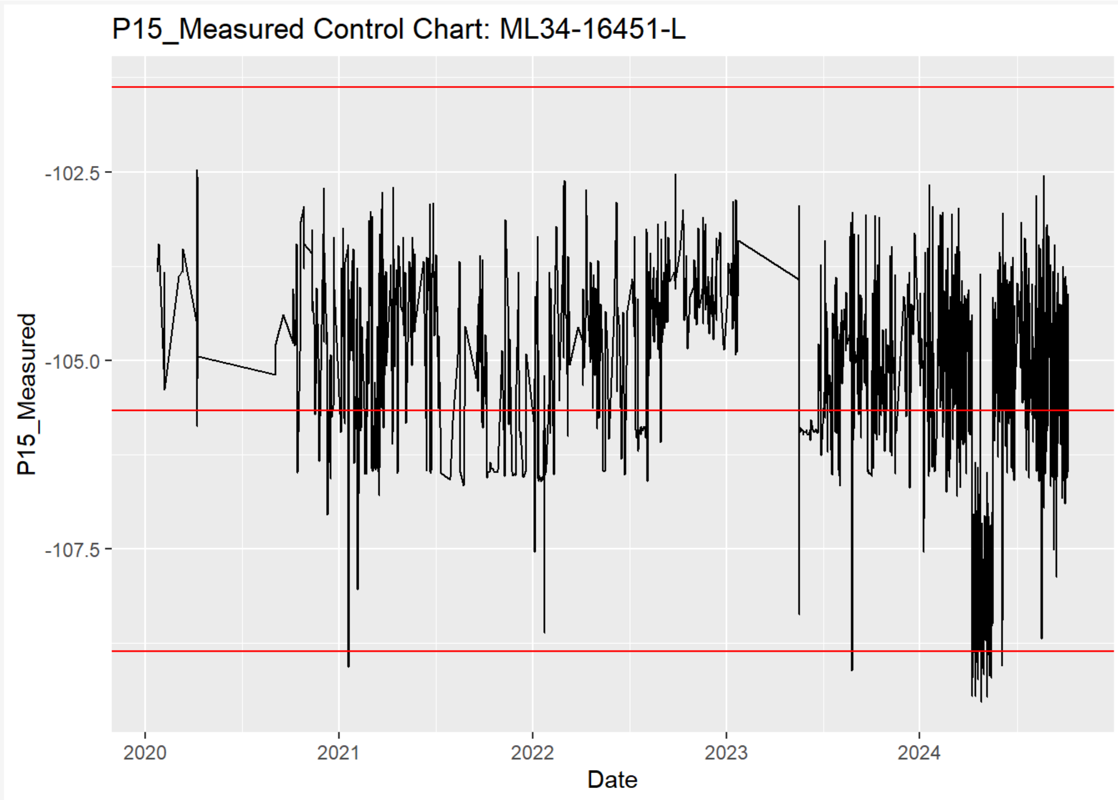

P10_Measured Control Chart: ML34-16451-L
P10_Measured
-113
-114
-115
-116
2020
2021
2022
2023
2024
Date

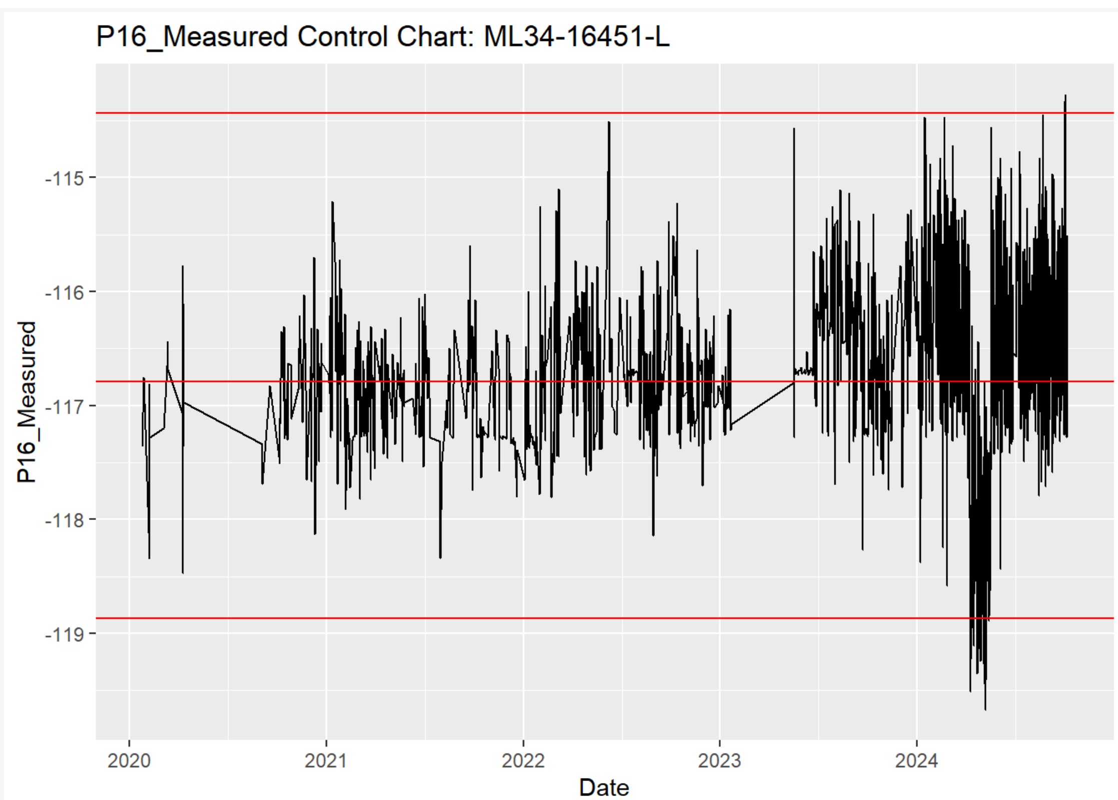

P11_Measured Control Chart: ML34-16451-L
247.5
245.0
242.5
240.0
237.5
P11_Measured
2020
2021
2022
2023
2024
Date

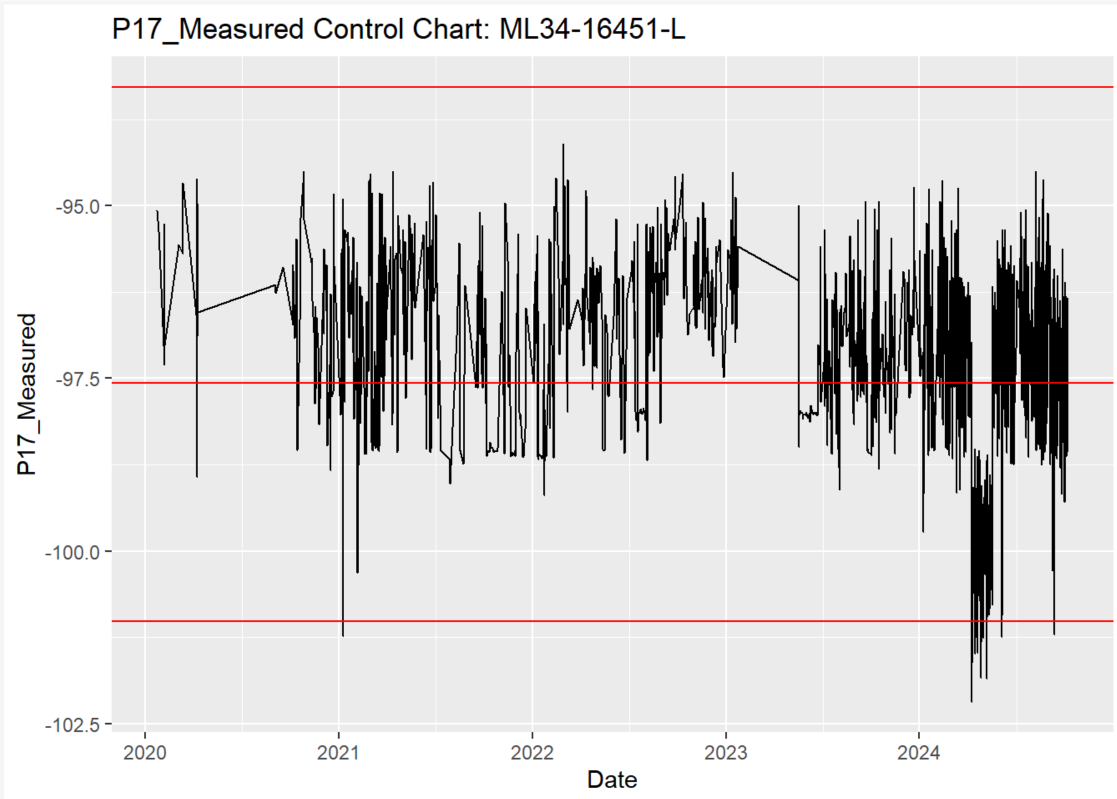

P12_Measured Control Chart: ML34-16451-L
-107
-108
-109
-110
-111
P12_Measured
2020
2021
2022
2023
2024
Date

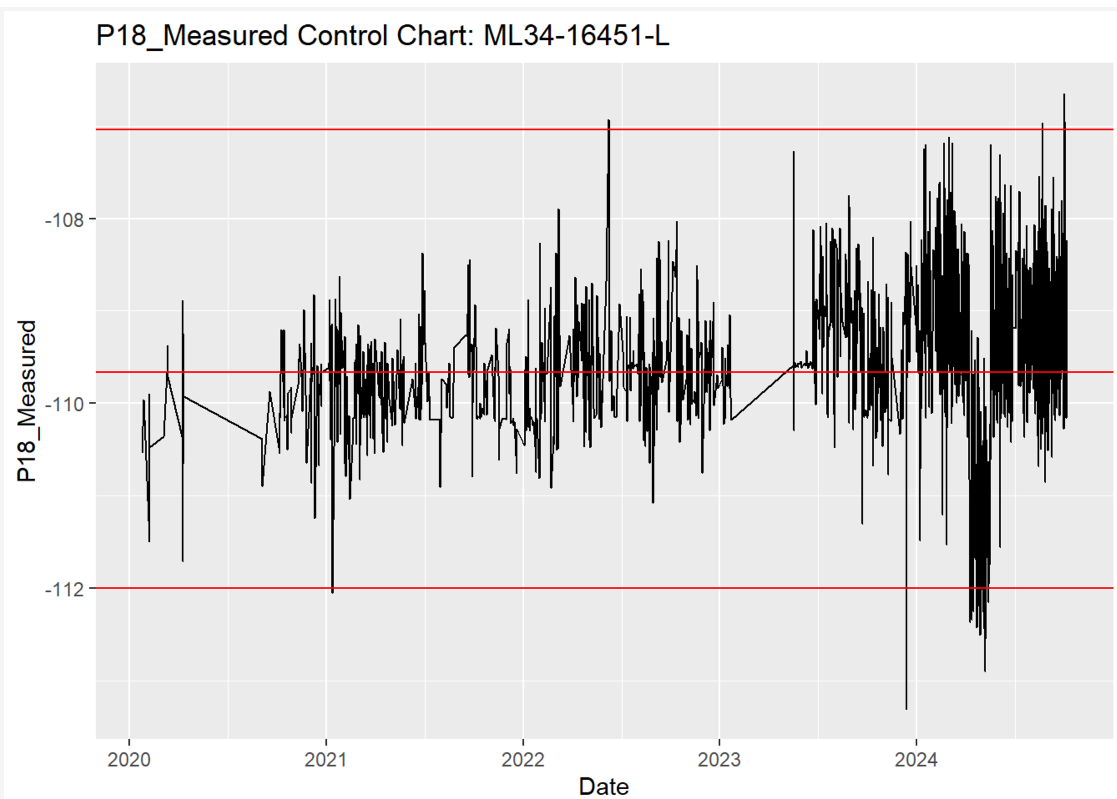

P13_Measured Control Chart: ML34-16451-L
-108
-109
-110
-111
-112
P13_Measured
2020
2021
2022
2023
2024
Date

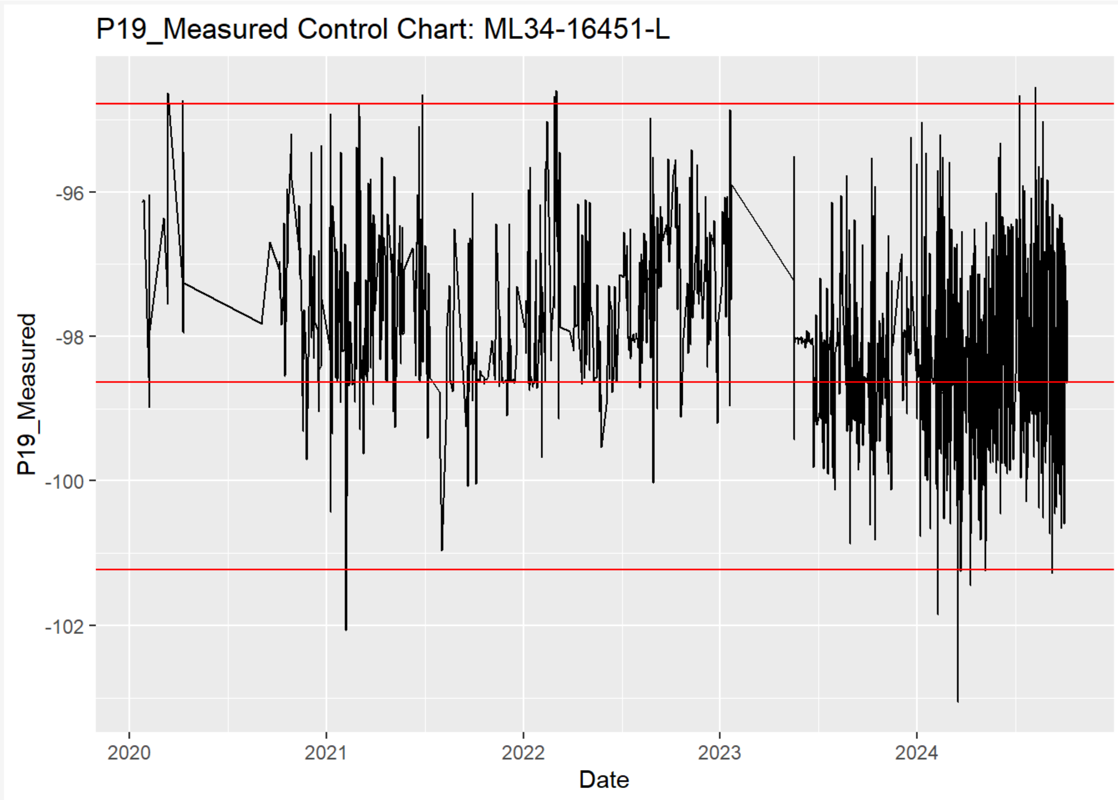

P14_Measured Control Chart: ML34-16451-L
247.5
245.0
242.5
240.0
P14_Measured
2020
2021
2022
2023
2024
Date

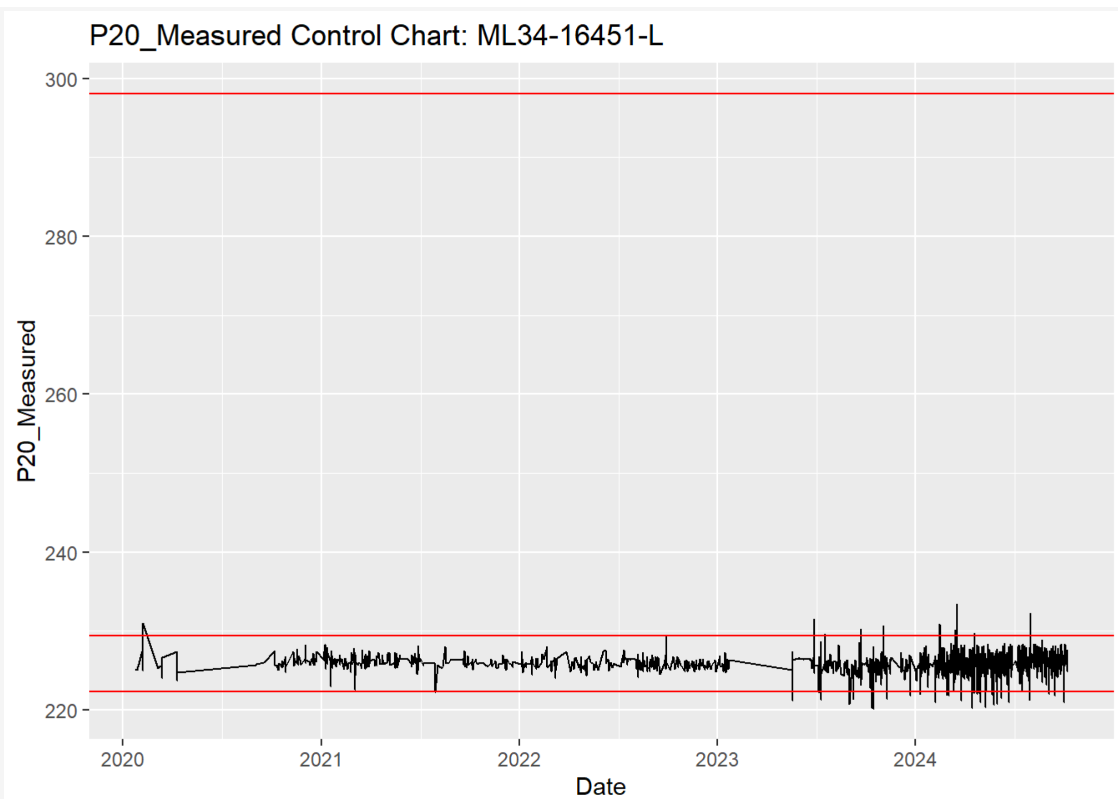

P15_Measured Control Chart: ML34-16451-L
-102.5
-105.0
-107.5
P15_Measured
2020
2021
2022
2023
2024
Date

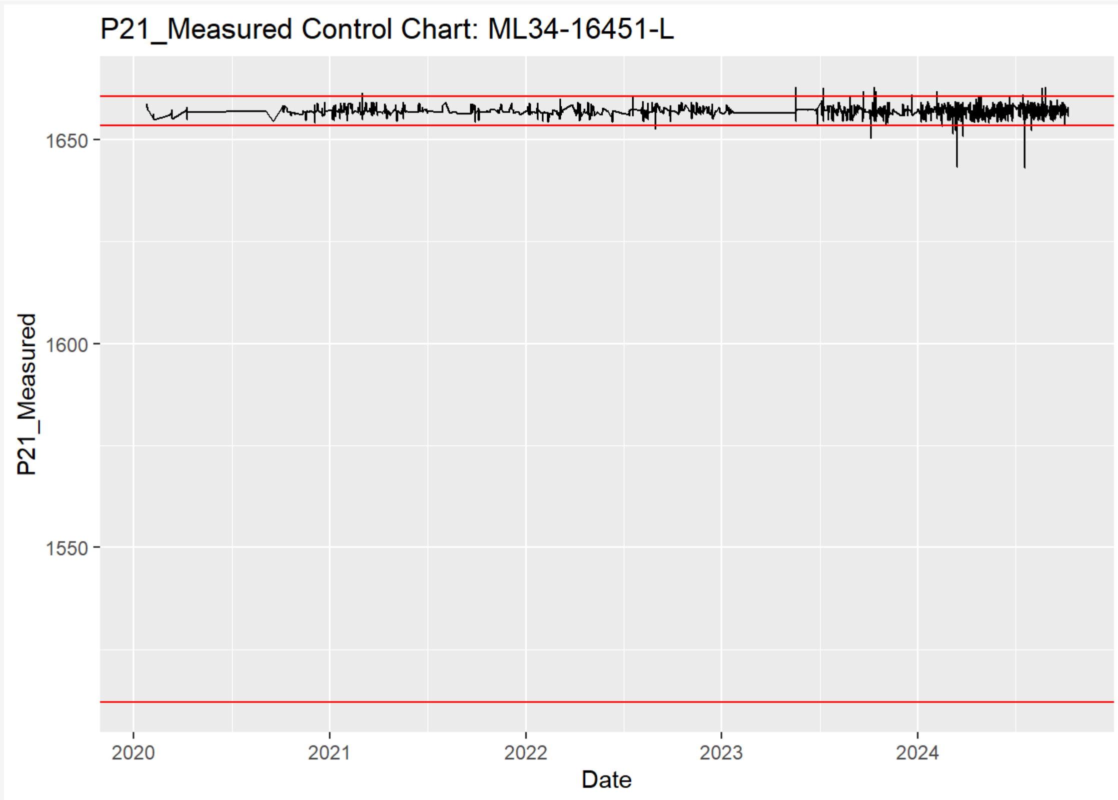

P16_Measured Control Chart: ML34-16451-L
-115
-116
-117
-118
-119
P16_Measured
2020
2021
2022
2023
2024
Date

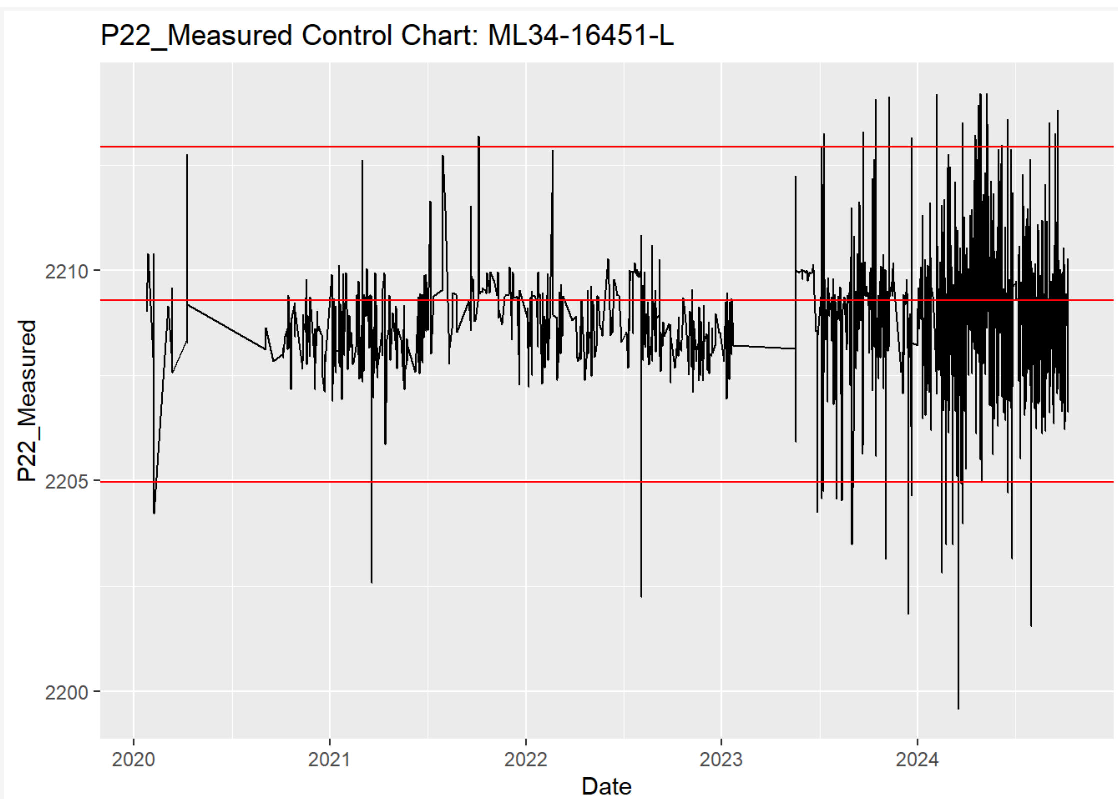

P17_Measured Control Chart: ML34-16451-L
P17_Measured
-95.0
-97.5
-100.0
-102.5
2020
2021
2022
2023
2024
Date


P18_Measured Control Chart: ML34-16451-L
P18_Measured
-108
-110
-112
2020
2021
2022
2023
2024
Date


P19_Measured Control Chart: ML34-16451-L
P19_Measured
-96
-98
-100
-102
2020
2021
2022
2023
2024
Date


P20_Measured Control Chart: ML34-16451-L
P20_Measured
300
280
260
240
220
2020
2021
2022
2023
2024
Date


P21_Measured Control Chart: ML34-16451-L
P21_Measured
1650
1600
1550
2020
2021
2022
2023
2024
Date


P22_Measured Control Chart: ML34-16451-L
P22_Measured
2210
2205
2200
2020
2021
2022
2023
2024
Date