



Test Monitoring Center

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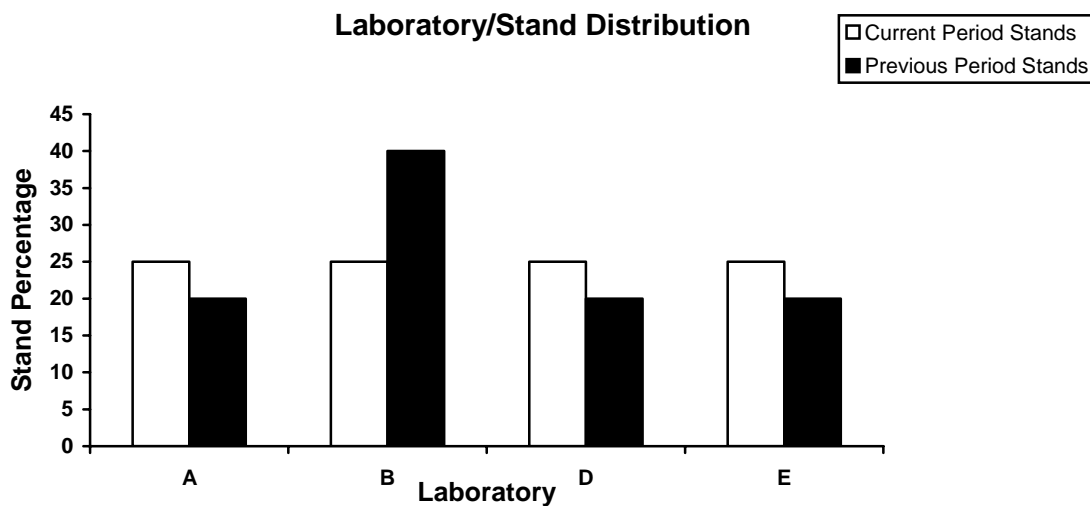
MEMORANDUM: 06-029
DATE: May 1, 2006
TO: Don Bartlett, Chairman, L-37 Surveillance Panel
FROM: Donald Lind
SUBJECT: L-37 Reference Test Status from October 1, 2005 through March 31, 2006

The following is a summary of the L-37 reference oil tests that were reported to the Test Monitoring Center during the period October 1, 2005 through March 31, 2006.

Lab/Stand Distribution

	Reporting Data	Calibrated as of 3/31/06
Number of Laboratories	4	4
Number of Stands	4	4

The following chart shows the laboratory/stand distribution:



The following summarizes the status of the reference oil tests reported to the TMC:

	TMC Validity Codes	Number of Tests
Operationally and Statistically Acceptable	AC	14
Failed Acceptance Criteria	OC	2
Operationally Invalid (Lab Judgment)	LC	0
Not Acceptable For Intended Purpose	MC	2
Aborted	XC	0
Total		18

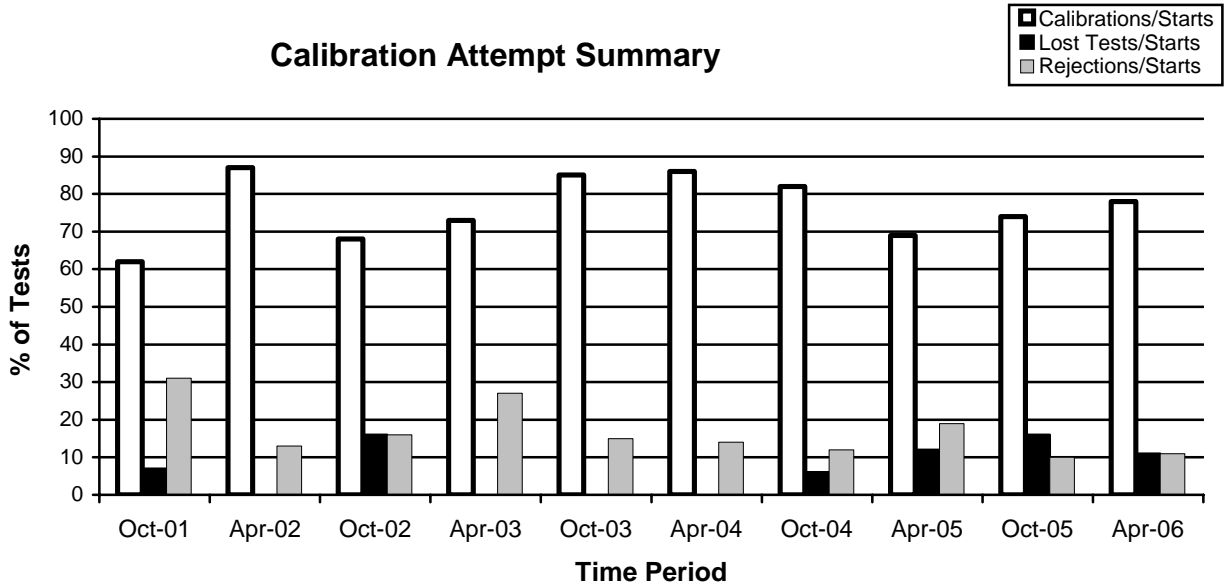
The following summarizes the acceptable and failed acceptance criteria tests by gear batch:

	Gear Batch	n-size	Acceptable	Failed Acceptance Criteria
Lubrited	L247/T758A	6	4	2
	V1L686/P4L626A	1	1	0
	V1L303/P4L514A	2	2	0
	Total	9	7	2
Non-lubrited	V1L176/P4L741A	1	1	0
	V1L351/P4T771	6	6	0
	Total	7	7	0

Additional Tests

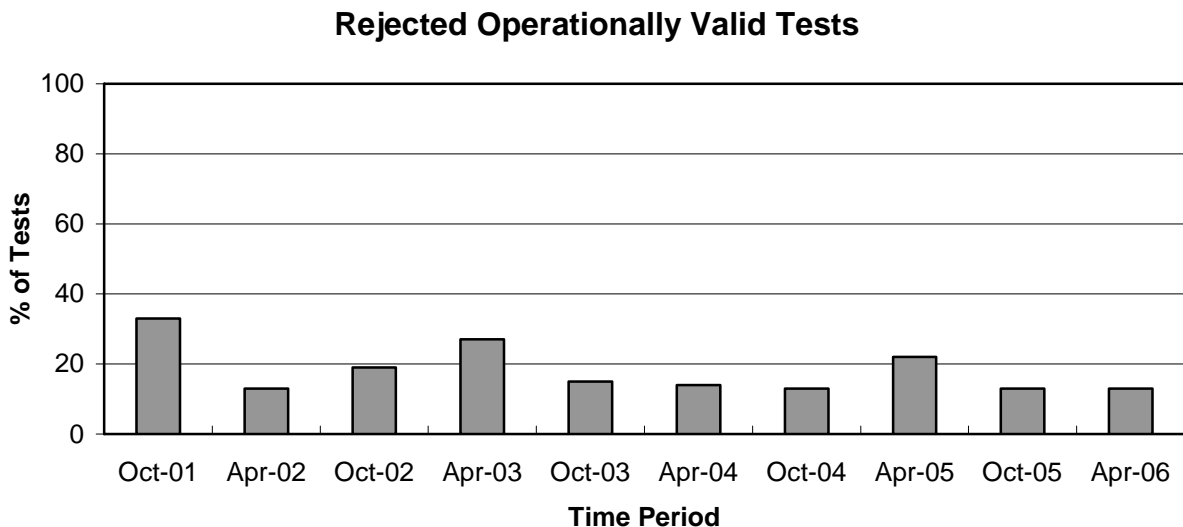
There were 40 additional tests conducted this report period. All 40 tests were conducted to evaluate new non-lubrited hardware, gear batch V1L417/P4L792.

Calibrations per start, lost tests per start and rejection per start rates are summarized below:



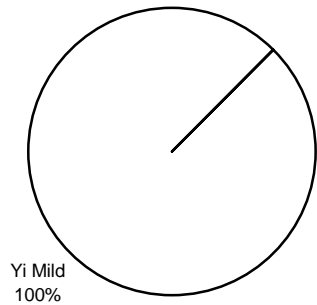
The calibration per start rate has increased with respect to the previous period. The lost test per start rate has decreased with respect to the previous period. The rejected per start rate has remained about the same as the previous period.

The operationally valid statistically rejected test rate, as shown below, remained the same as the previous period.

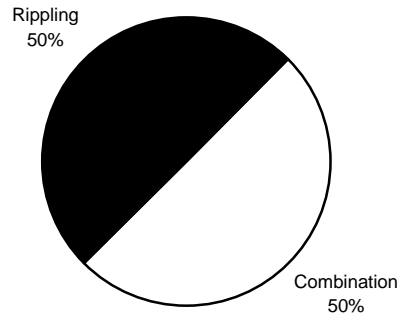


A detailed list of reasons tests failed the acceptance criteria is shown in Table 1. The following charts summarize these reasons with a breakdown by parameter of the failed tests.

Distribution of LTMS Stand Alarms



Distribution of Stand Alarms by Parameter



There were no LTMS deviations written this period.

The laboratory distribution of lost tests is shown below. A detailed list of reasons for tests declared operationally invalid, aborted or non-interpretable are shown in Table 2.



Severity and Precision

The mean Δ/s by gear batch, overall mean Δ/s , and shift in merits for the operationally valid calibration tests reported this period are tabulated below for lubrified and non-lubricated hardware. Severity is summarized for this report period by laboratory, hardware, and gear batch in the attached Table 3.

LUBRICATED HARDWARE						
Parameter	Gear Batch	N	Δ/s	s^D	Overall Δ/s	Overall Shift In Merits
Wear	V1L686/P4L626A	1	-0.97	----	-0.26	-0.15 ^C
	L247/T758A	6	-0.33	1.14		
	V1L303/P4L514A	2	0.27	0.00		
Ridging	V1L686/P4L626A	1	-1.20	----	-0.28	-0.19 ^{A,C}
	L247/T758A	6	-0.11	1.08		
	V1L303/P4L514A	2	-0.30	0.00		
Rippling	V1L686/P4L626A	1	0.10	----	0.50	0.28 ^{A,C}
	L247/T758A	6	0.85	1.48		
	V1L303/P4L514A	2	-0.35	1.62		
Pitt/Spall	V1L686/P4L626A	1	0.21	----	0.19	0.09 ^{B,C}
	L247/T758A	6	0.60	1.01		
	V1L303/P4L514A	2	-1.03	0.00		

^A Level for determining shift in merits (8.0)

^B Level for determining shift in merits (9.3)

^C Used SA standard deviation as published in the LTMS document for determining shift in merits

^D A straight standard deviation was used. The number of tests conducted this report period was too small to calculate an accurate pooled standard deviation.

NON-LUBRICATED HARDWARE						
Parameter	Gear Batch	N	Δ/s	s^D	Overall Δ/s	Overall Shift In Merits
Wear	V1L351/P4T771	6	-0.18	0.84	-0.32	-0.22 ^C
	V1L176/P4L741A	1	-1.16	----		
Ridging	V1L351/P4T771	6	-0.11	0.93	-0.14	-0.19 ^{A,C}
	V1L176/P4L741A	1	-0.33	----		
Rippling	V1L351/P4T771	6	-0.26	0.54	-0.31	-0.28 ^{A,C}
	V1L176/P4L741A	1	-0.61	----		
Pitt/Spall	V1L351/P4T771	6	-0.09	0.47	-0.05	-0.03 ^{B,C}
	V1L176/P4L741A	1	0.21	----		

^A Level for determining shift in merits (8.0)

^B Level for determining shift in merits (9.3)

^C Used SA standard deviation as published in the LTMS document for determining shift in merits

^D A straight standard deviation was used. The number of tests conducted this report period was too small to calculate an accurate pooled standard deviation.

Industry Control Charts

Lubrited

Figures 1 through 4 are the lubrited industry control charts for pinion Wear, Rippling, Ridging, and Pitting/Spalling, respectively. Figures 5 through 8 are the lubrited industry control charts of the last 20 test results for pinion Wear, Rippling, Ridging, and Pitting/Spalling, respectively. Severity and precision EWMA charts for pinion Wear, Ridging, Rippling, and Pitting/Spalling were in control this report period.

Non-lubrited

Figures 9 through 12 are the non-lubrited industry control charts for pinion Wear, Rippling, Ridging, and Pitting/Spalling, respectively. Figures 13 through 16 are the non-lubrited industry control charts of the last 20 test results for pinion Wear, Rippling, Ridging, and Pitting/Spalling, respectively. Severity and precision EWMA charts for pinion Wear, Ridging, Rippling, and Pitting/Spalling were in control this report period.

TMC Lab Visits

There was one lab visit this report period with several discrepancies to report. The discrepancies are listed below:

1. The front spray nozzles were not at the specified 45° angles as specified in Figure A5.1.
2. The front spray nozzles were not $9 \frac{1}{4} \pm \frac{1}{2}$ inch from the rear flange of the cover mating surface as specified in Figure A5.1.
3. The top nozzle did not comply with the specifications of $7 \frac{1}{8} \pm \frac{1}{2}$ inch from the rear flange cover mating surface and the $8 \frac{3}{4} \pm \frac{1}{2}$ inch from axle centerline.
4. The cover plate spray nozzles were not at the specified 45° and 60° angles as specified in Figure A5.1.
5. The cover plate spray nozzles were not $1 \frac{1}{2} \pm \frac{1}{2}$ inches from cover plate as specified in Figure A5.1.

Information Letters

There was one information letter issued this report period. Information Letter 06-1, Sequence Number 35 was issued on February 15, 2006. Items changed with this information letter are documented in the L-37 timeline (Table 4).

Reference Oil Status

The following is a listing of reference oils with the expected number of tests remaining at the Test Monitoring Center and at the testing laboratories. L-37 reference oils are shipped in quantities of one gallon per test.

Oil	Number of Tests Remaining				
	Lab A	Lab B	Lab D	Lab E	TMC
127	3	3	3	2	10
128-1	4	4	5	5	8
128-2	4	3	5	2	256
151-3	5	6	4	4	*
152	6	6	5	6	5
152-1	0	0	0	0	165
153	6	6	6	6	11
153-1	0	0	0	0	156
155	4	5	4	4	**

* 14 Gallons (Multiple test area usage)

** 466 Gallons (Multiple test area usage)

DML/dml

Attachments

c: <ftp://ftp.astmtmc.cmu.edu/docs/gear/137/semiannualreports/137-04-2006.pdf>

L-37 Surveillance Panel

J. L. Zalar

F. M. Farber

Distribution: Email

Listing of Tables and Figures Included as Part of This Report to the L-37 Surveillance Panel

Table 1 Summarizes the Reasons for Failed Tests

Table 2 Summarizes the Reasons for Lost Tests

Table 3 is the Severity Summary for This Report Period by Laboratory, Hardware, and Gear Batch

Table 4 is the L-37 Industry Timeline

Figure 1 is the Industry Control Chart for Pinion Wear (Lubrited Hardware)

Figure 2 is the Industry Control Chart for Pinion Rippling (Lubrited Hardware)

Figure 3 is the Industry Control Chart for Pinion Ridging (Lubrited Hardware)

Figure 4 is the Industry Control Chart for Pinion Pitting/Spalling (Lubrited Hardware)

Figure 5 is the Industry Control Chart of the last 20 test results for Pinion Wear (Lubrited Hardware)

Figure 6 is the Industry Control Chart of the last 20 test results for Pinion Rippling (Lubrited Hardware)

Figure 7 is the Industry Control Chart of the last 20 test results for Pinion Ridging (Lubrited Hardware)

Figure 8 is the Industry Control Chart of the last 20 test results for Pinion Pitting/Spalling (Lubrited Hardware)

Figure 9 is the Industry Control Chart for Pinion Wear (Non-Lubrited Hardware)

Figure 10 is the Industry Control Chart for Pinion Rippling (Non-Lubrited Hardware)

Figure 11 is the Industry Control Chart for Pinion Ridging (Non-Lubrited Hardware)

Figure 12 is the Industry Control Chart for Pinion Pitting/Spalling (Non-Lubrited Hardware)

Figure 13 is the Industry Control Chart of the last 20 test results for Pinion Wear (Non-Lubrited Hardware)

Figure 14 is the Industry Control Chart of the last 20 test results for Pinion Rippling (Non-Lubrited Hardware)

Figure 15 is the Industry Control Chart of the last 20 test results for Pinion Ridging (Non-Lubrited Hardware)

Figure 16 is the Industry Control Chart of the last 20 test results for Pinion Pitting/Spalling (Non-Lubrited Hardware)

Table 1
Summary of Reasons for Rejected Tests

Reasons	No. of Tests
Stand Shewhart Severity Alarms (Rippling and Spitting Mild)	1
Stand Shewhart Severity Alarm (Rippling Mild)	1

Table 2
Lost Tests Summary

Tests declared operationally invalid, aborted or non-interpretable are summarized below by laboratory, reason, number of lost tests, and percent of lost tests:

LAB	REASON	Tests Lost	% of Tests Lost
B	Test non-interpretable due to broken pinion teeth	1	14%
D	Test non-interpretable due to broken pinion teeth	1	17%

Table 3

Severity Summary for This Report Period by Laboratory, Hardware, and Gear Batch

Mean Δ/s (LUBRITED HARDWARE)																
	Wear				Ridging				Rippling				Pitt/Spall			
	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E
V1L686 P4L626 A	-0.97	----	----	----	-1.20	----	----	----	0.10	----	----	----	0.21	----	----	----
L247/ T758A	----	-0.34	-0.69	0.42	----	-0.79	0.58	0.54	----	1.99	0.06	-1.01	----	0.49	0.51	1.12
V1L303/ P4L514 A	0.27	0.27	----	----	-0.30	-0.30	----	----	-1.49	0.80	----	----	-1.03	-1.03	----	----

Mean Δ/s (NON-LUBRITED HARDWARE)																
	Wear				Ridging				Rippling				Pitt/Spall			
	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E	Lab A	Lab B	Lab D	Lab E
V1L176/ P4L741A	----	----	----	-1.16	----	----	----	-0.33	----	----	----	-0.61	----	----	----	0.21
V1L351/ P4T771	-0.20	-0.46	-0.93	1.18	0.22	-0.76	1.09	-0.65	0.05	-0.46	0.12	-0.84	-0.48	0.14	0.08	0.08

Table 4

L-37 Timeline		
Effective Date	Topic	IL#
19931221	Report Forms and Dictionary Version 19931209	1
19940104	Rear Cover Plate Sensor Loc.	2
19940104	Data Reporting Response Time	2
19940317	Referencing Schedule	3
19940428	Report Forms and Dictionary Version 19940422	4
19940728	Report Forms and Dictionary Version 19940707	5
19950820	Rating Scale Revision	6
19950820	Report Form 5 Wording Change	6
19950820	Report Forms and Dictionary Version 19950424	6
19960309	Rating Revisions of the Rating Scale	96-1
19960325	Rating Revisions affecting Spalling and Pitting	96-2
19960116	TMC Address	96-2
19960603	Report Forms and Dictionary Version 19960425	96-3
19960603	Revised Wording of Rating Scale	96-3
19960317	Rating Revisions to the Wear Step Area	96-4
19970825	Revised Reference Testing Frequency and Number of Tests for Stands Out of Calibration > 6 months	97-1
19980309	Report Forms and Dictionary Version 19971223	98-1
19980309	Revised Alternate Rating Method For Drive Side Pinion Gear Pitting Values on Gear Set C1L426/P4L415A	98-1
19980309	Test Reporting Clarifications	98-1
19980309	Revisions to Stand Calibration Requirements	98-2
19980309	Restrictions On Reference Oil Analysis	98-2
19980309	Reporting of Non-standard Tests to the TMC	98-2
19980309	LTMS Implementation	98-2
19980310	Report Forms and Dictionary Version 19980203	98-3
19980603	Deviation Percentage Calculation Clarification	98-4
19980901	Combining of Pitting and Spalling Ratings	98-4
19981116	Numerical Rating Precision Clarification	98-5
19990101	Developed Reference Oil Test Targets by Gear Batch (Grandfathered For All Test Starting 19950101)	
19990113	Addition of Exclusion Zone for Determining the Pitting/Spalling Result on Non-lubrited Hardware, Gear Batch V1L303/P4L514A	99-1
19990113	Deletion of Section A8.3.5	99-1
19990503	Updated Reference oil 128-1 Targets (18 Tests), Gear Batch V1L303/P4L514A (Grandfathered For All Test Starting 19950101)	
19990510	Revisions to Precision and Bias Statement	99-2
19990728	Cover Plate Thermocouple Location	99-3
20000613	Root/Tip Polishing Comment for V1L686/P4L626A Non-lubrited Gears	00-1, Sequence No. 20
20000613	Pitting/Spalling Table A9.1 Clarifications	00-1, Sequence No. 20
20001001	CRC Reference Photography of Gear Distress Photographs	00-2, Sequence No. 21
20001115	Correction Factor for V1L686/P4L626A Lubrited Gears	01-1, Sequence No. 22
20010612	Ring Correction Factor for V1L686/P4L626A Lubrited Gears	01-2, Sequence No. 23
20011101	Addition of Annex 12 Addressing Distress Rating Exclusion Comments	01-2, Sequence No. 23
20011101	Revised Report Forms	01-2, Sequence No. 23
20020101	CRC Rating Manual 21	02-1, Sequence No. 24
20020211	Revised Report Forms and Data Dictionary	02-1, Sequence No. 24
20020211	Rating With Magnification	02-2, Sequence No. 25

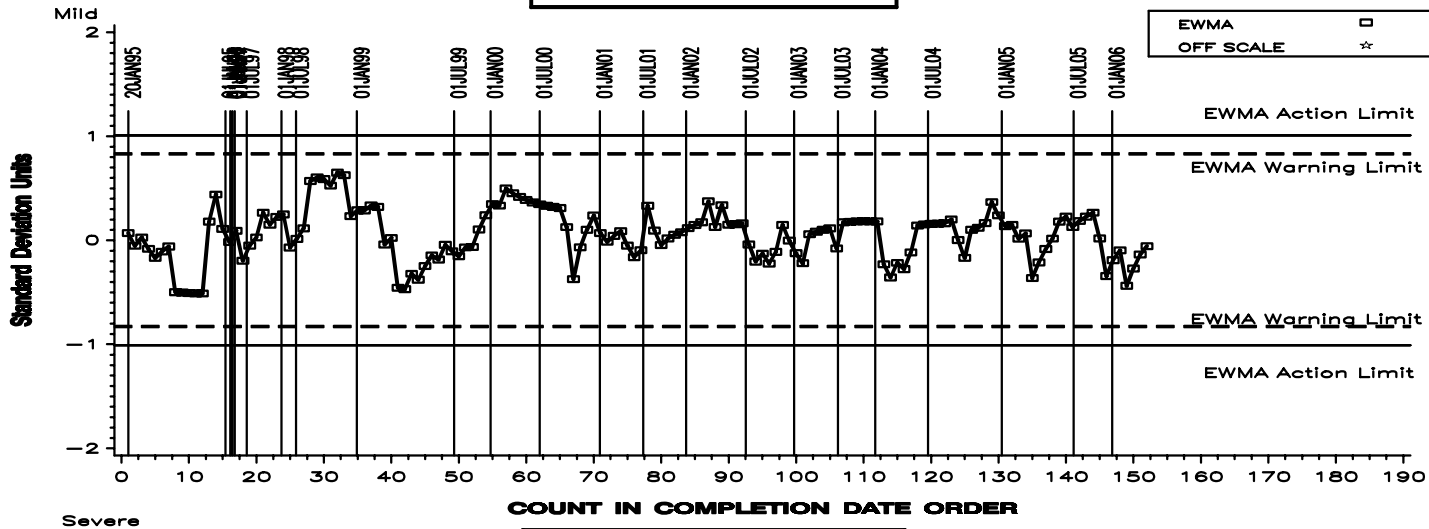
Table 4 (Continued)

L-37 Timeline		
Effective Date	Topic	IL#
20030401	Rater Calibration Monitoring System	03-1, Sequence No. 26
20030327	Revised Wear Rating Definitions	03-2, Sequence No. 27
20030421	Deletion of Catastrophic Distress Levels for Wear, Rippling, and Ridging	03-3, Sequence No. 28
20030421	Non-interpretable Tests	03-3, Sequence No. 28
20030421	Tooth Breakage	03-3, Sequence No. 28
20030421	Rating Corrosion On Ring and Pinion	03-3, Sequence No. 28
20030909	Addition of SAE J2360 As a Reference Document	03-4, Sequence No. 29
20030909	Revised Speed Specification for Balancing Dynamometer Connecting Shafts	03-4, Sequence No. 29
20030909	Revised Speed Specification for Balancing Drive Shafts	03-4, Sequence No. 29
20030909	Revised Test Axle Preparation	03-4, Sequence No. 29
20030909	Revised Note 1	03-4, Sequence No. 29
20030909	Discontinue Optional Inspection of Gear Set	03-4, Sequence No. 29
20030909	Shutdown and Downtime Revisions	03-4, Sequence No. 29
20030909	Recording Test Parameters	03-4, Sequence No. 29
20030909	New Note 2 for Gear Test Phase Conditions	03-4, Sequence No. 29
20040101	Revised Cleaning Solvent Specification	03-4, Sequence No. 29
20040630	Standardization Revisions	04-1, Sequence No. 30
20040825	Lubrited Hardware, Gear Batch V1L686/P4L626A Correction Factor	04-1, Sequence No. 30
20040917	Intermediate Precision and Reproducibility Revisions	04-1, Sequence No. 30
20040922	Drive Shaft Wall Thickness	04-2, Sequence No. 31
20040922	Alternating Lubrited and Non-lubrited Hardware	04-2, Sequence No. 31
20041115	Revised Drive Shaft and Axle Shaft Specifications	04-3, Sequence No. 32
20041115	Revised Drawing for the Spray Nozzles Location	04-3, Sequence No. 32
20050204	Non-lubrited Hardware, Gear Batch V1L351/P4T771 Approval	
20050218	Revise Solvent Specification	05-1, Sequence No. 33
20050218	Donated Reference Oil Test Programs/Calibration Period Length Adjustment	05-1, Sequence No. 33
20050504	Updated Test Precision	05-2, Sequence No. 34
20050504	Rounding Test Results Using ASTM E 29	05-2, Sequence No. 34
20060208	Correction Factor for L247/T758A Lubrited Gear Batch	06-1, Sequence No. 25

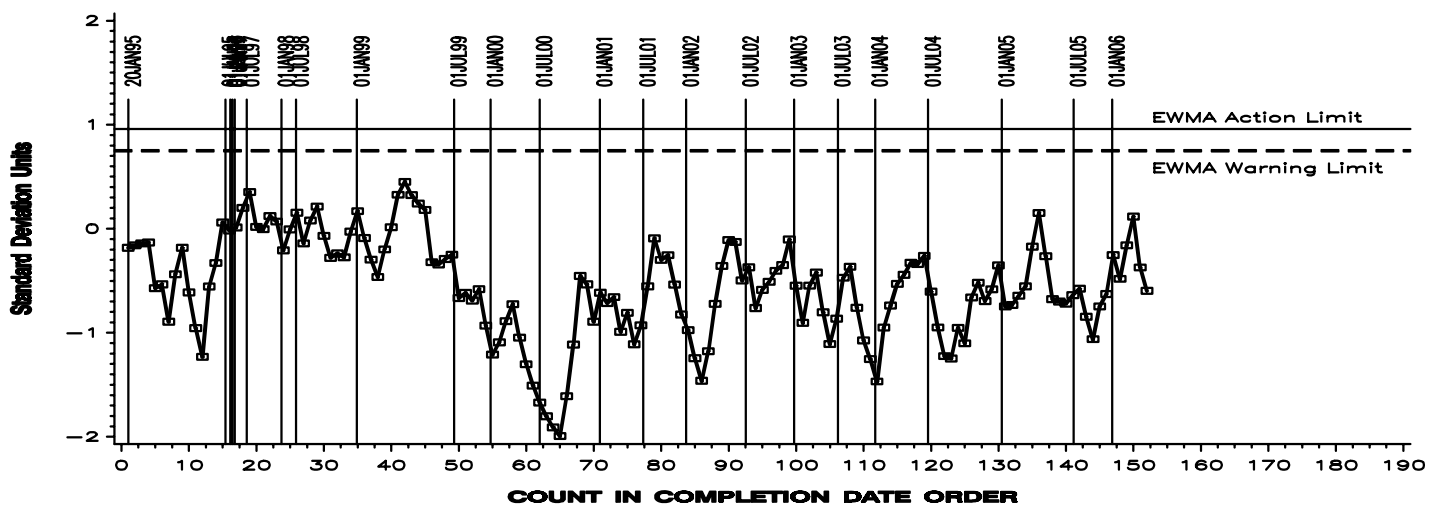
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR WEAR

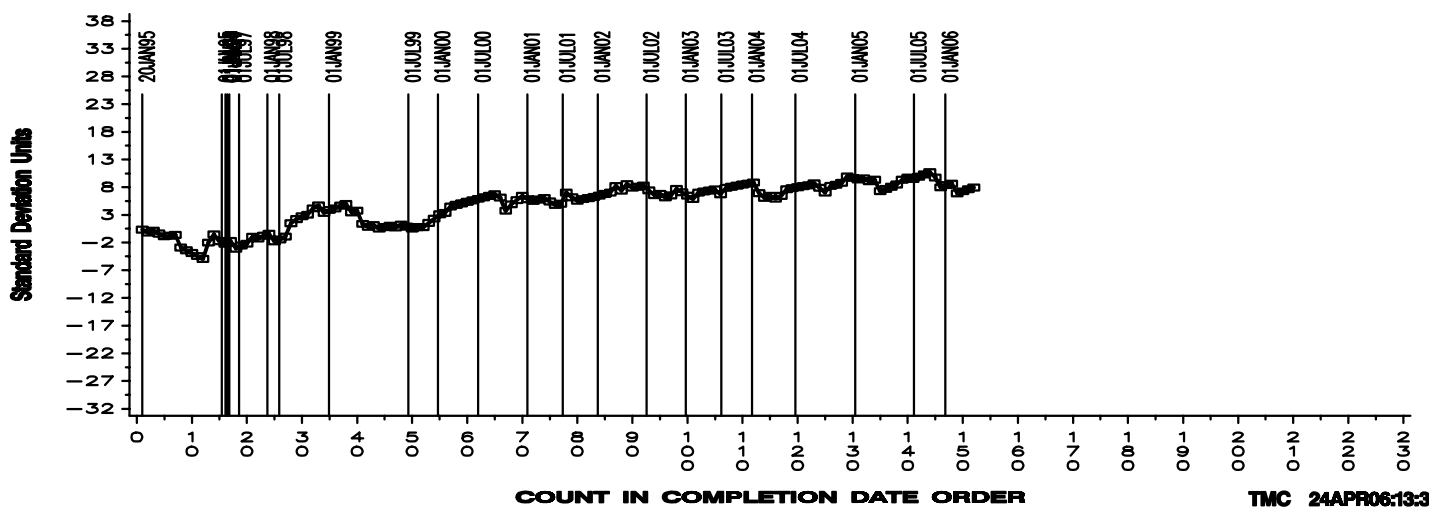
LTMS Severity Analysis



LTMS Precision Analysis



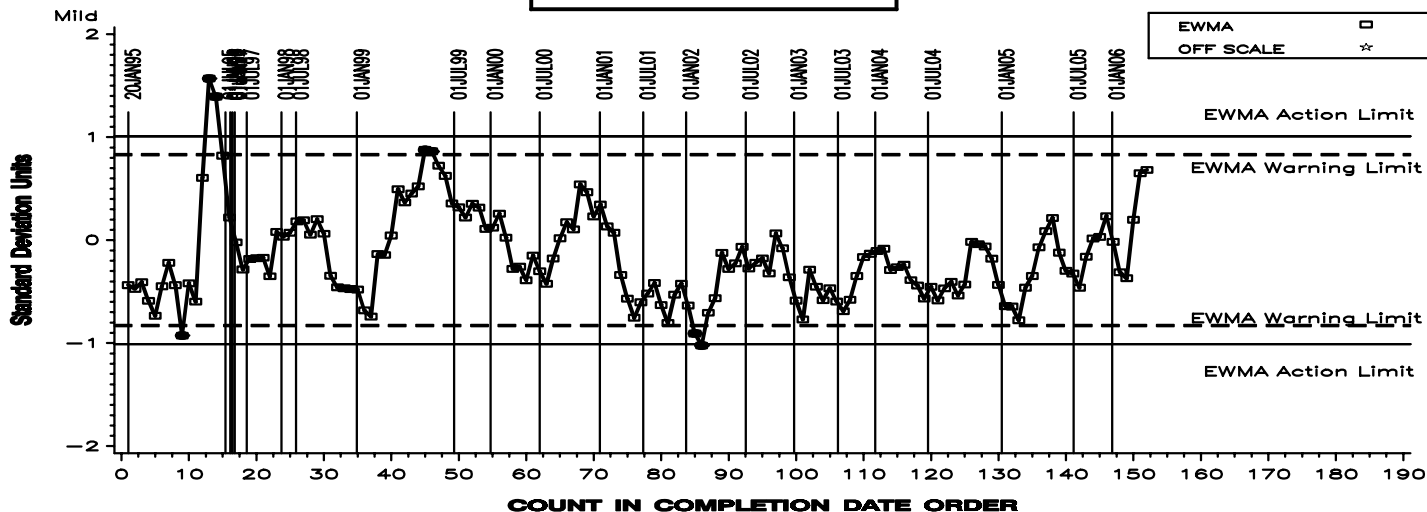
CUSUM Severity Analysis



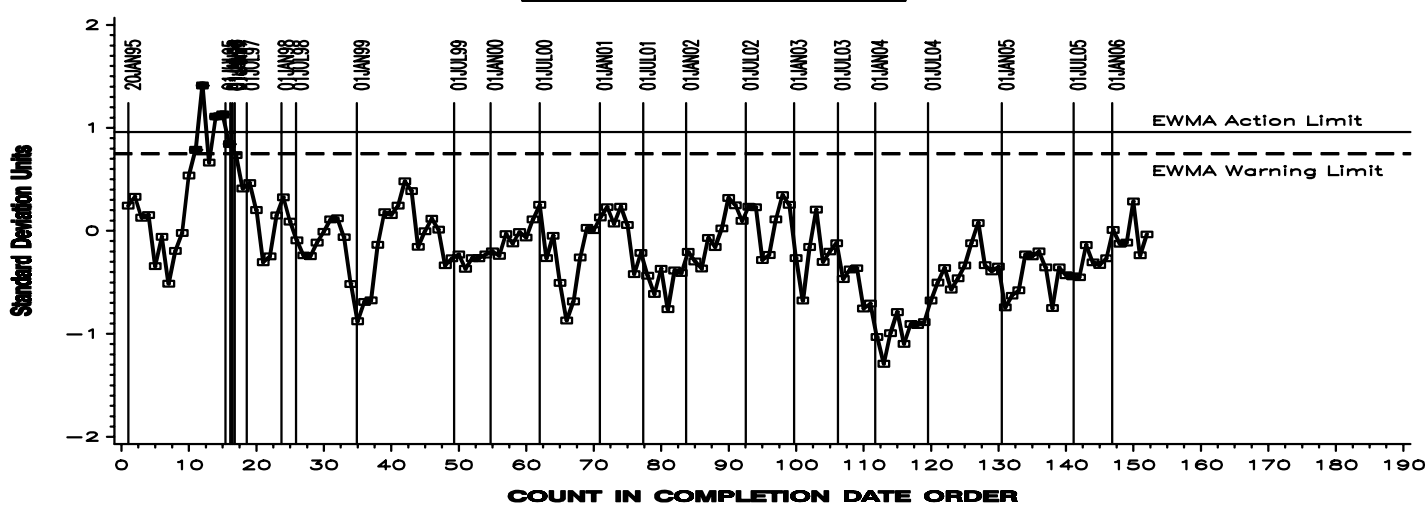
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIPPING

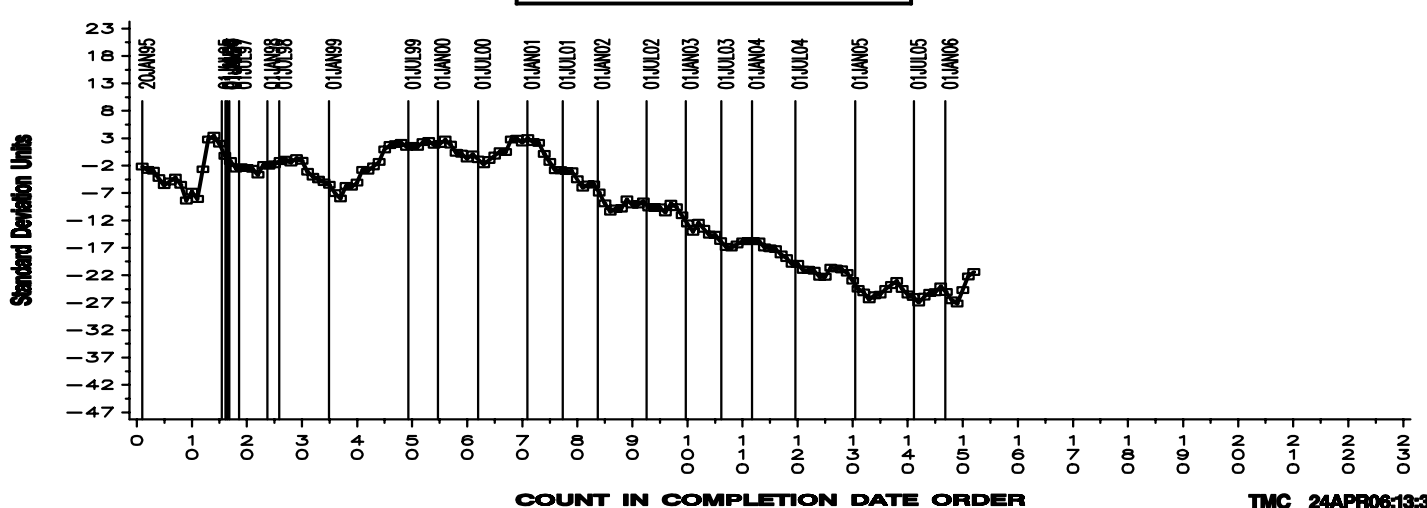
LTMS Severity Analysis



LTMS Precision Analysis



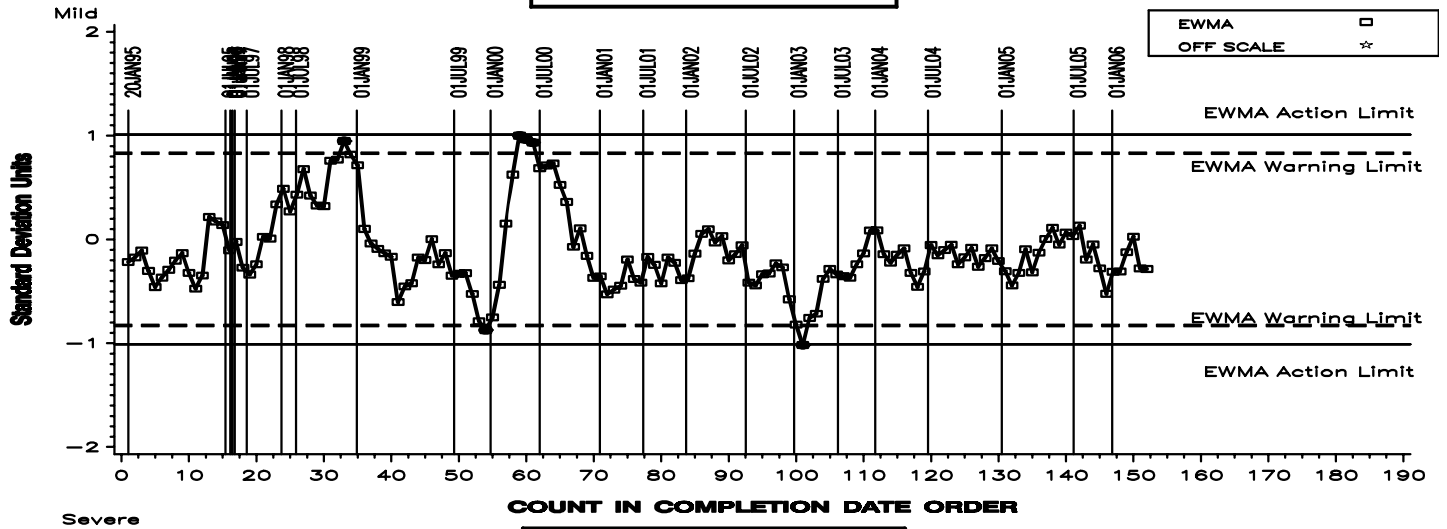
CUSUM Severity Analysis



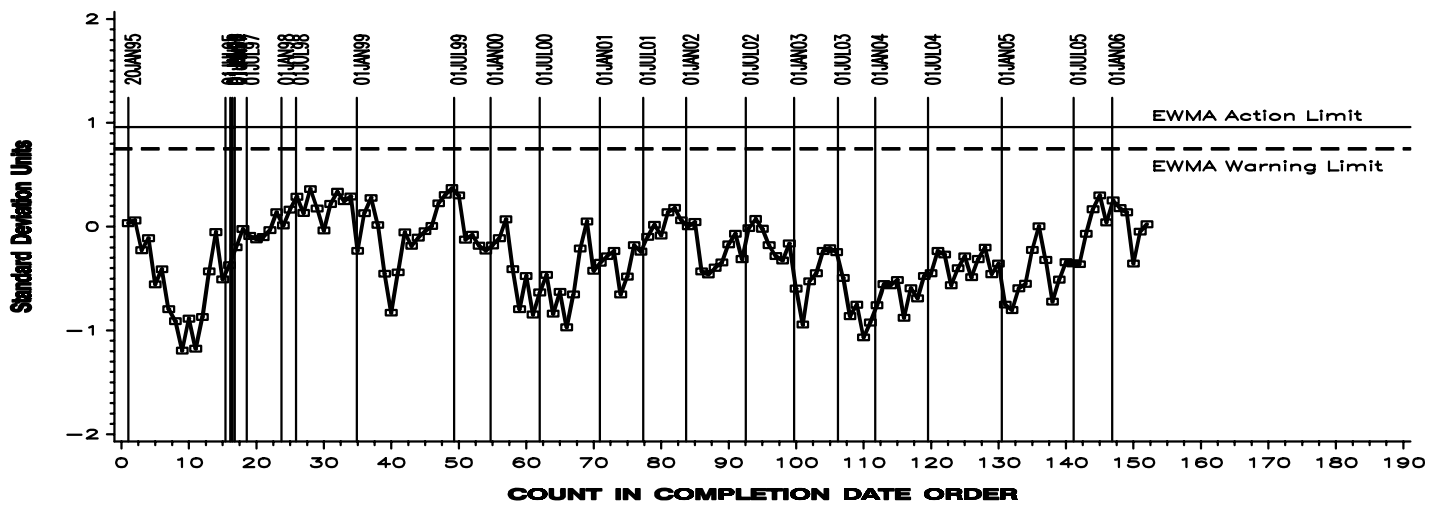
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIDGING

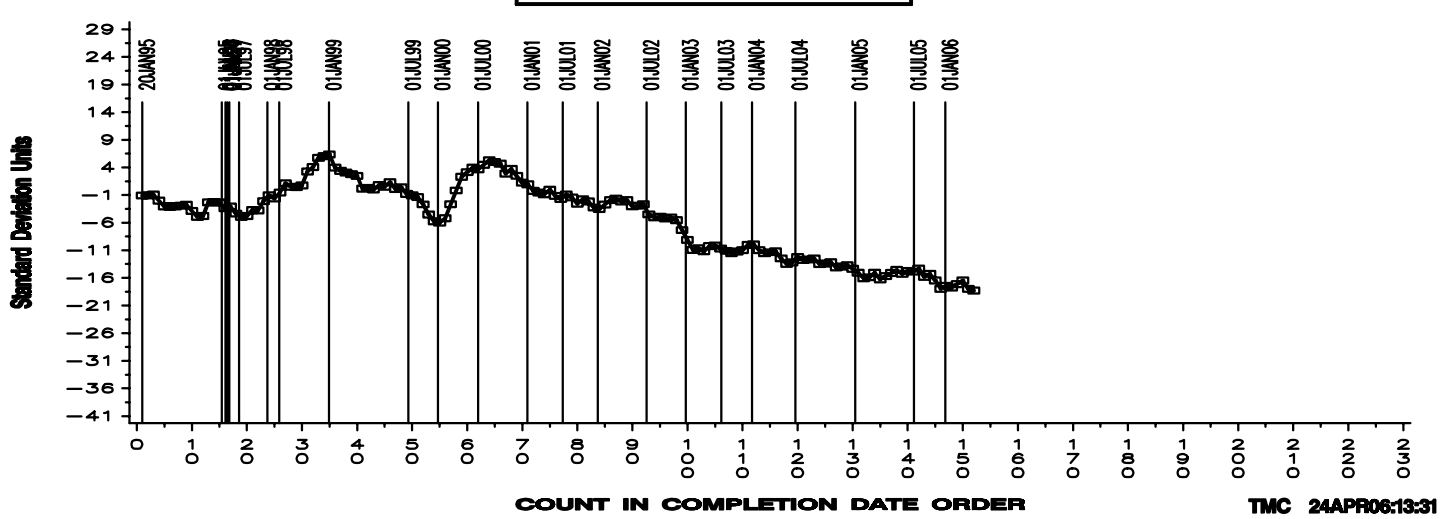
LTMS Severity Analysis



LTMS Precision Analysis



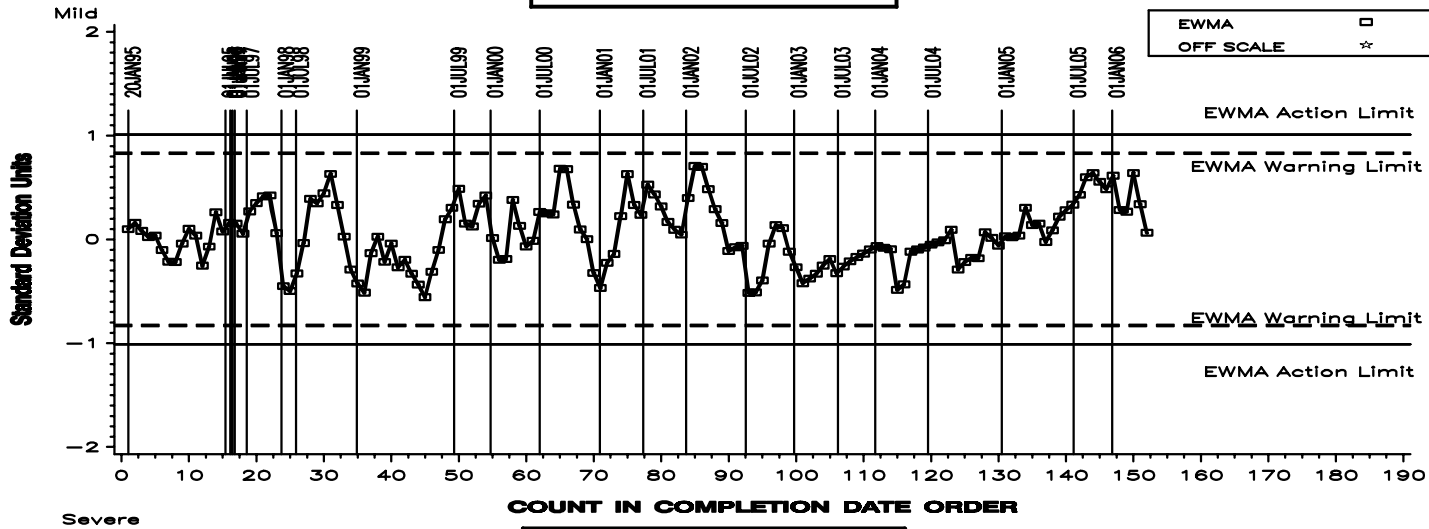
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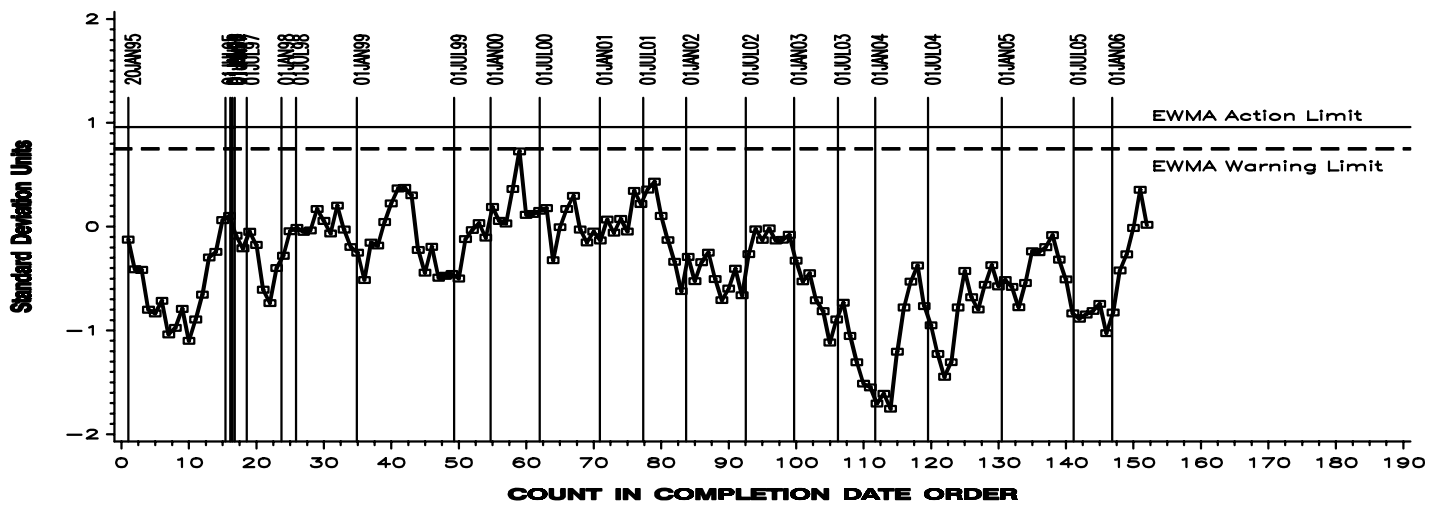
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR PITTING/SPALLING

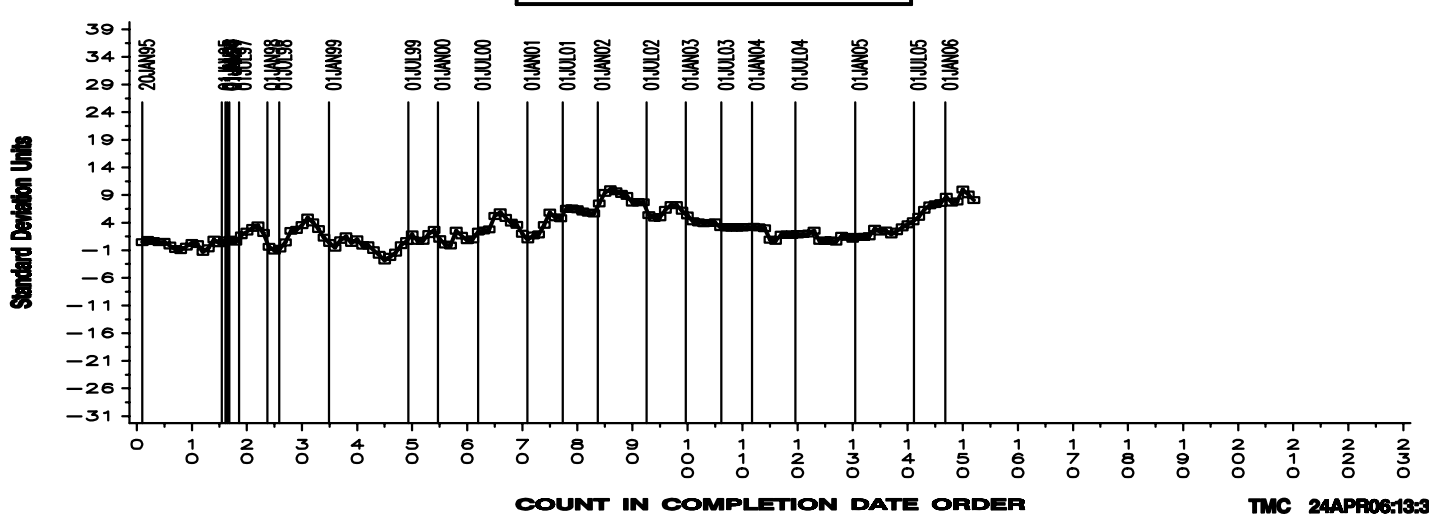
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

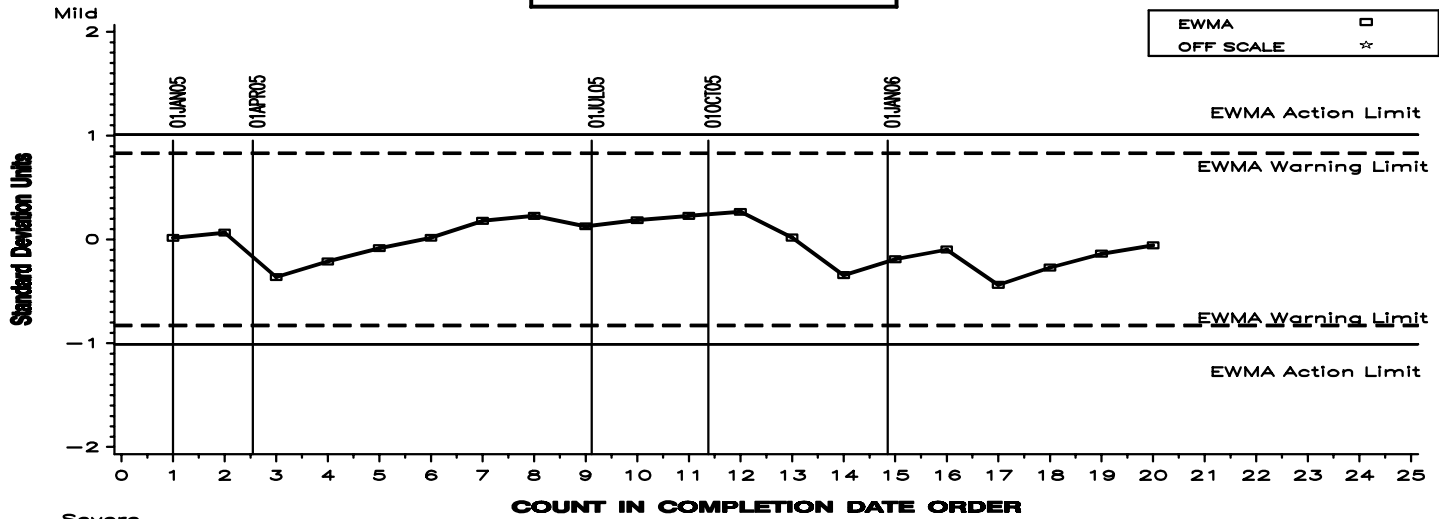


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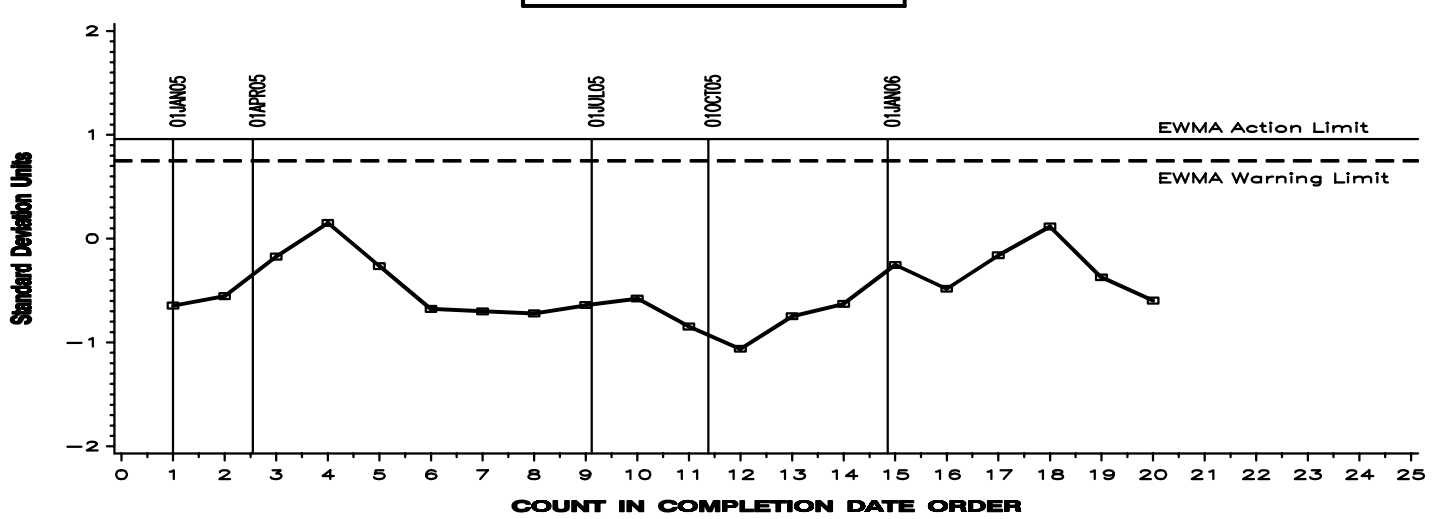
LAST 20 DATA POINTS

FINAL PINION GEAR WEAR

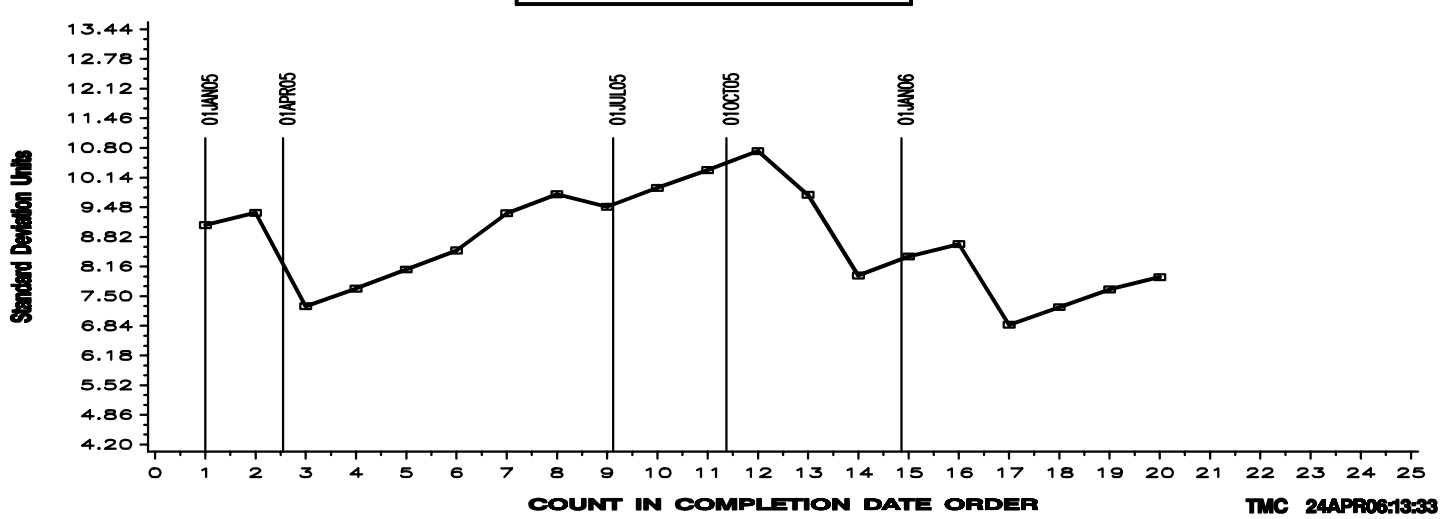
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

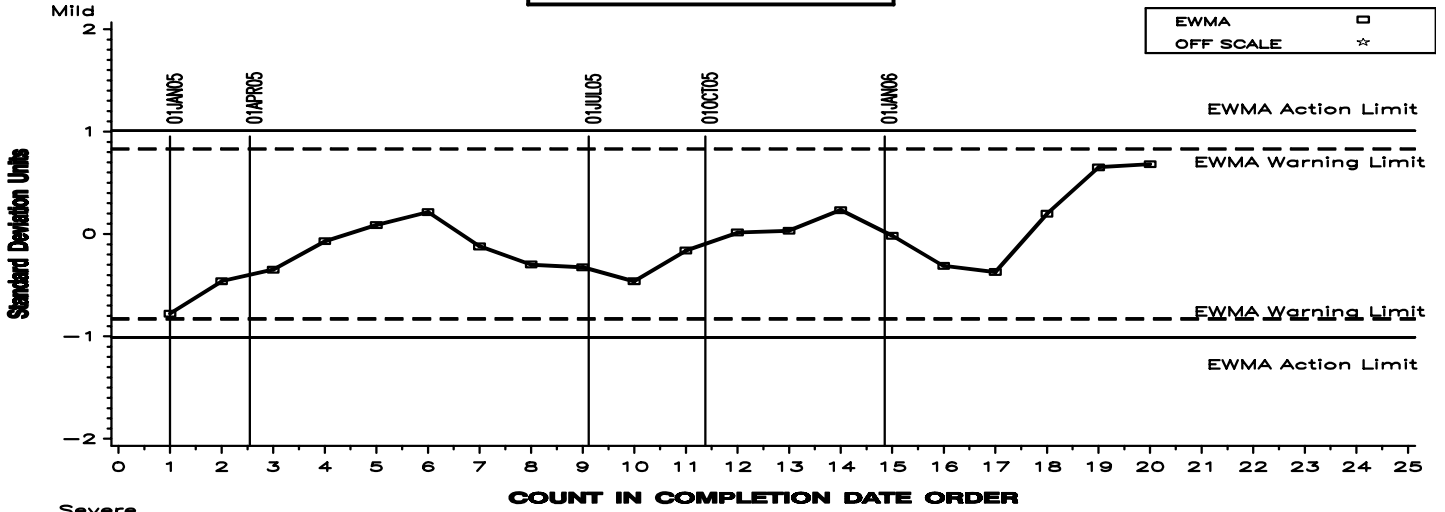


L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

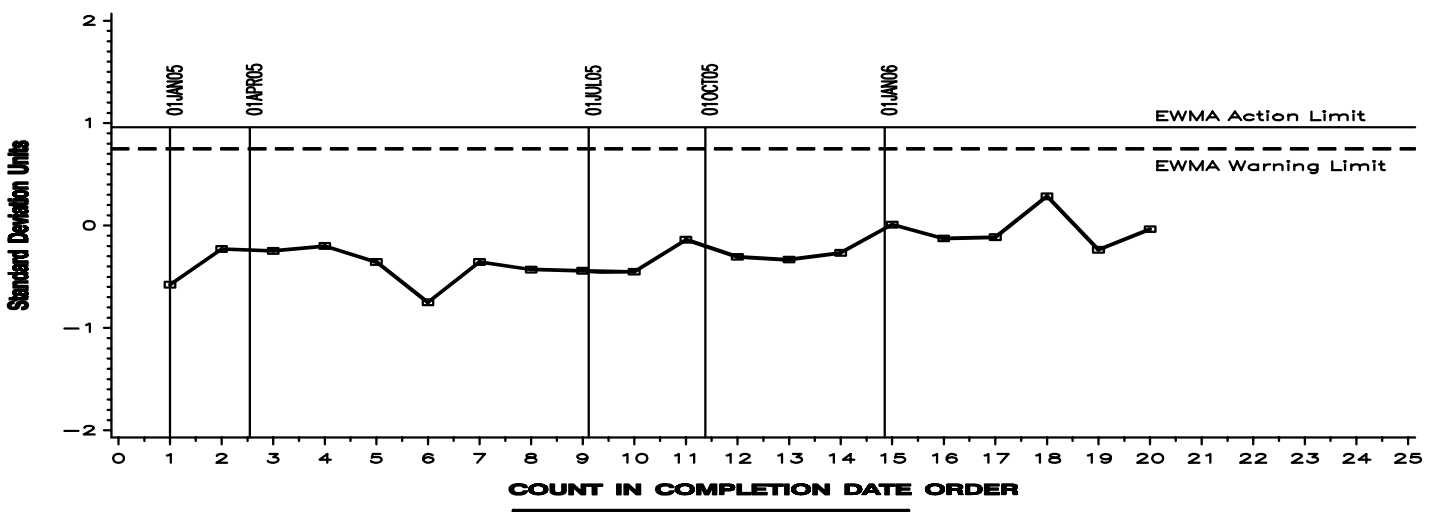
LAST 20 DATA POINTS

FINAL PINION GEAR RIPPLING

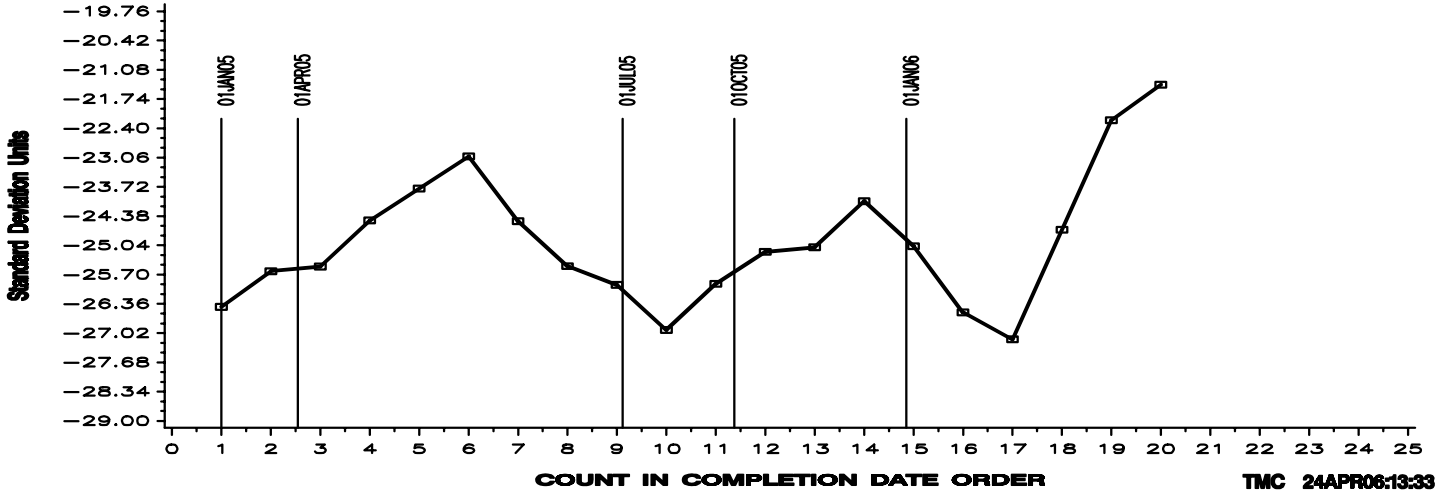
LTMS Severity Analysis



LTMS Precision Analysis



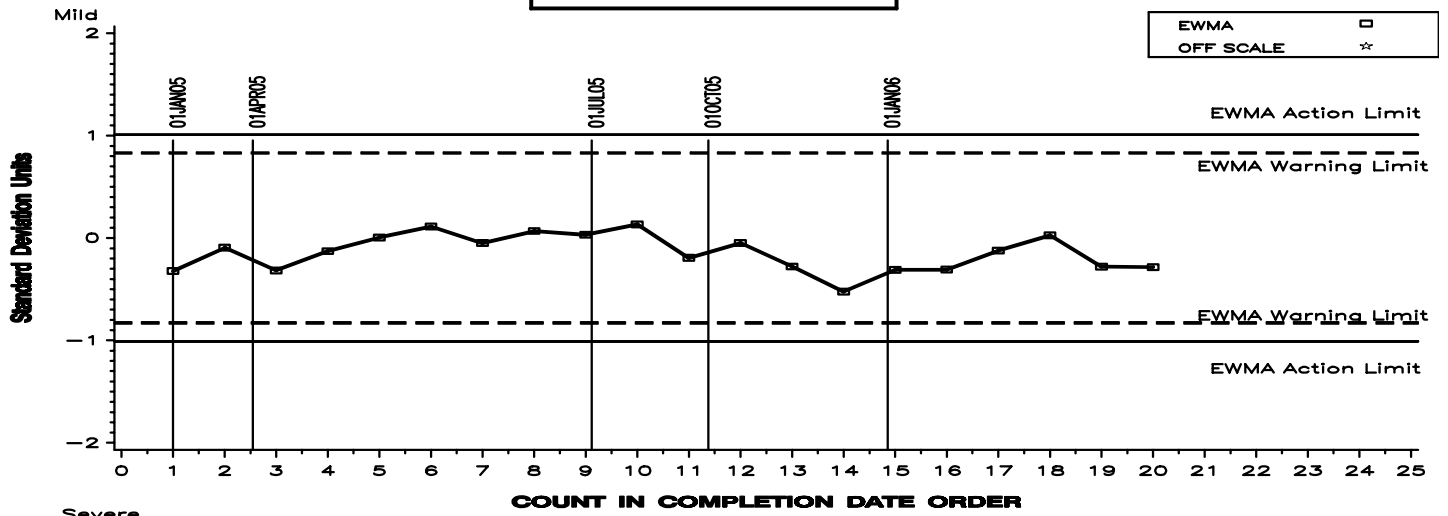
CUSUM Severity Analysis



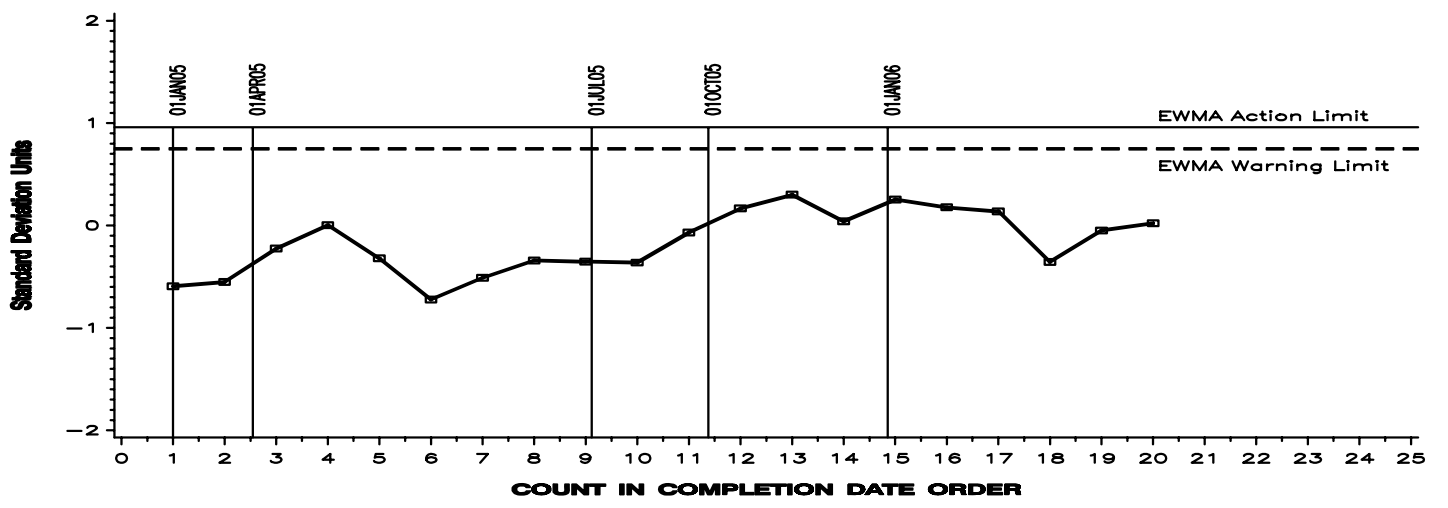
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

LAST 20 DATA POINTS FINAL PINION GEAR RIDGING

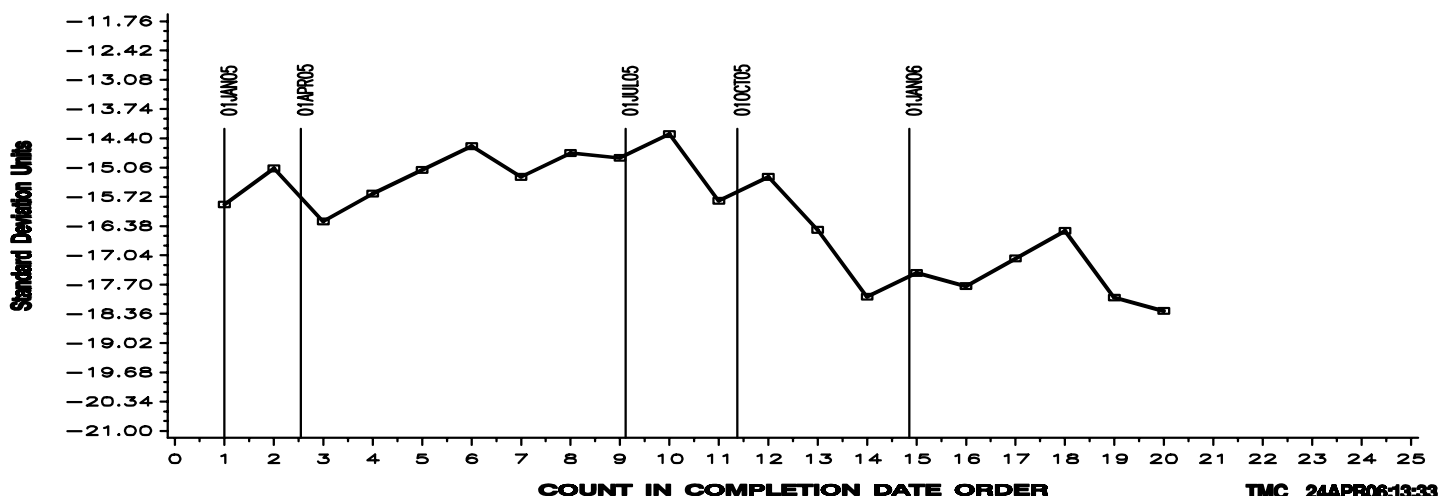
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

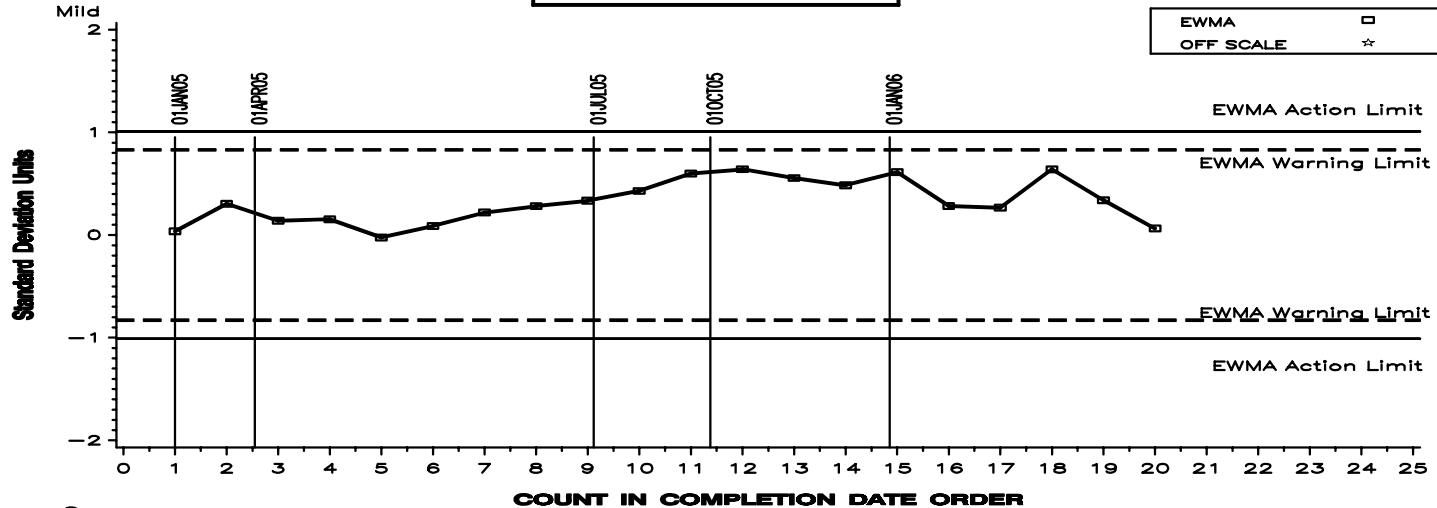


L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

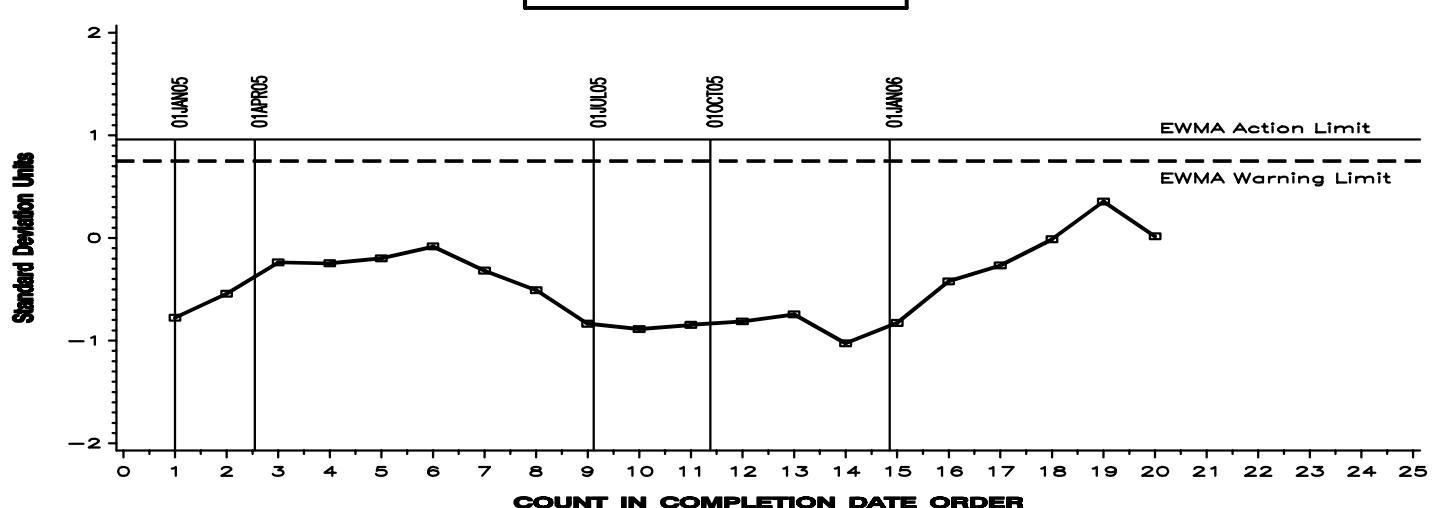
LAST 20 DATA POINTS

FINAL PINION GEAR PITTING/SPALLING

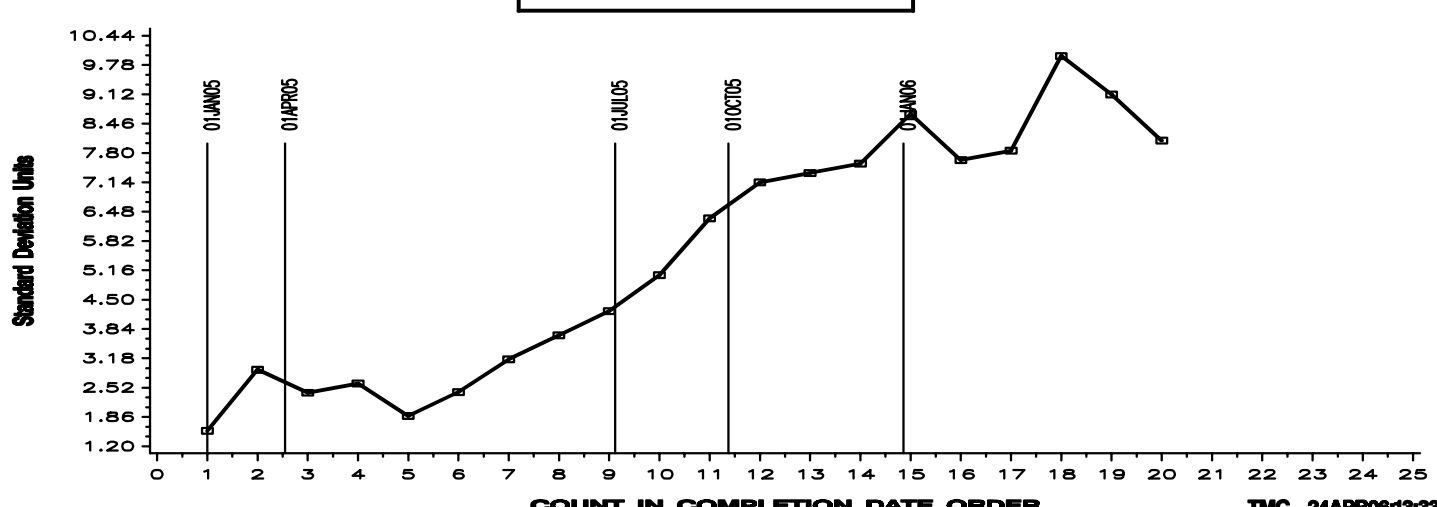
LTMS Severity Analysis



LTMS Precision Analysis



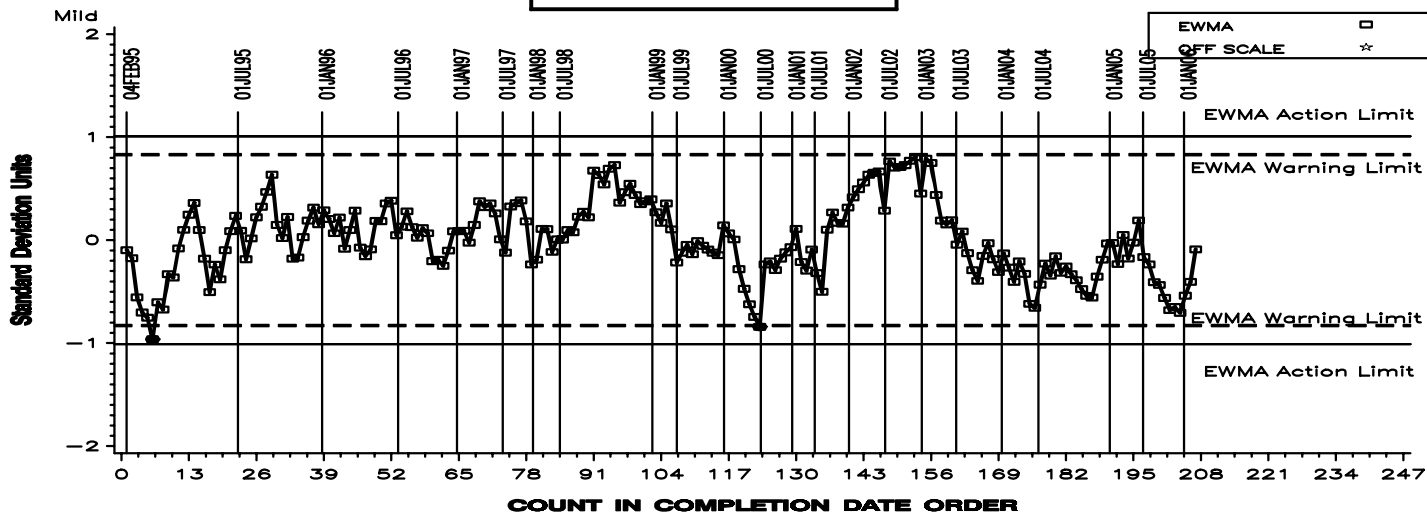
CUSUM Severity Analysis



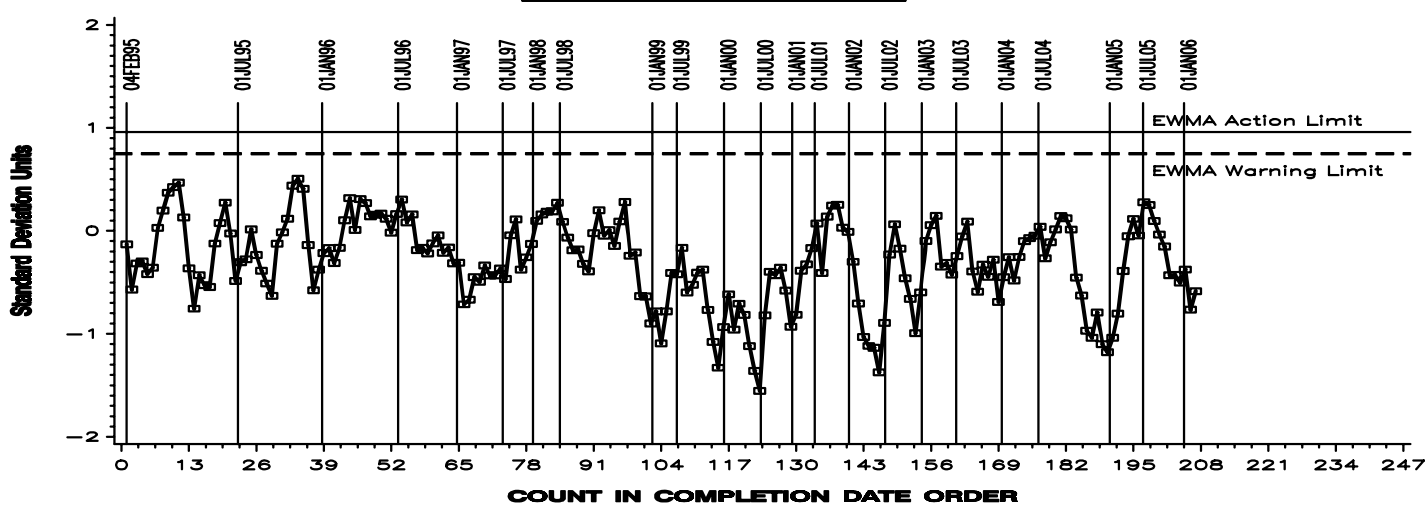
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR WEAR

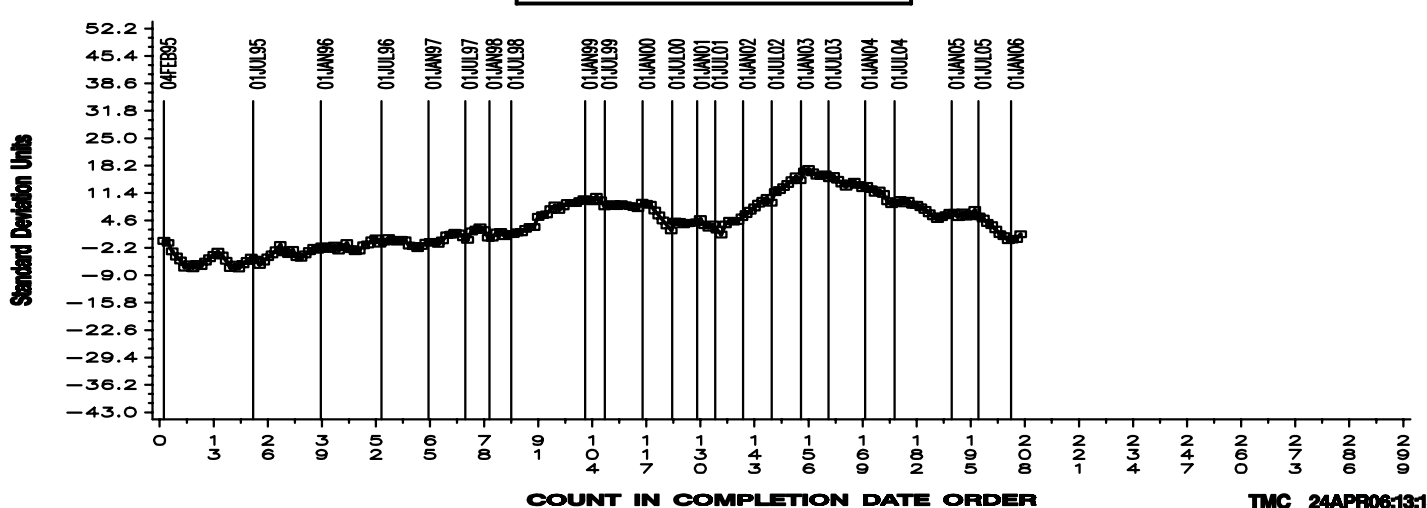
LTMS Severity Analysis



LTMS Precision Analysis



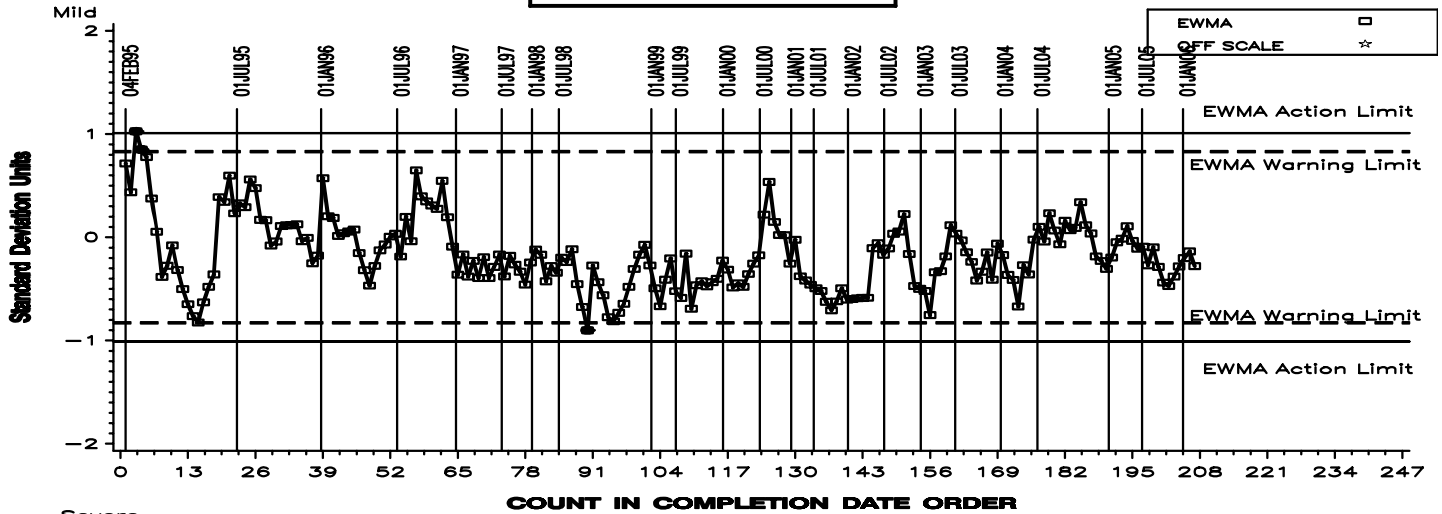
CUSUM Severity Analysis



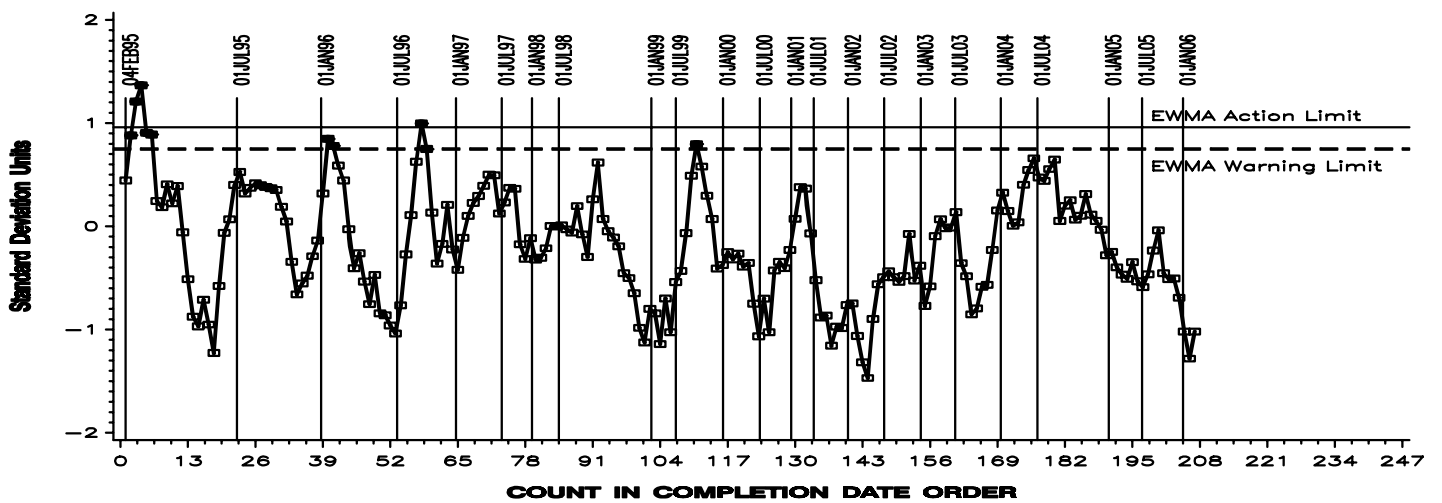
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIPPLING

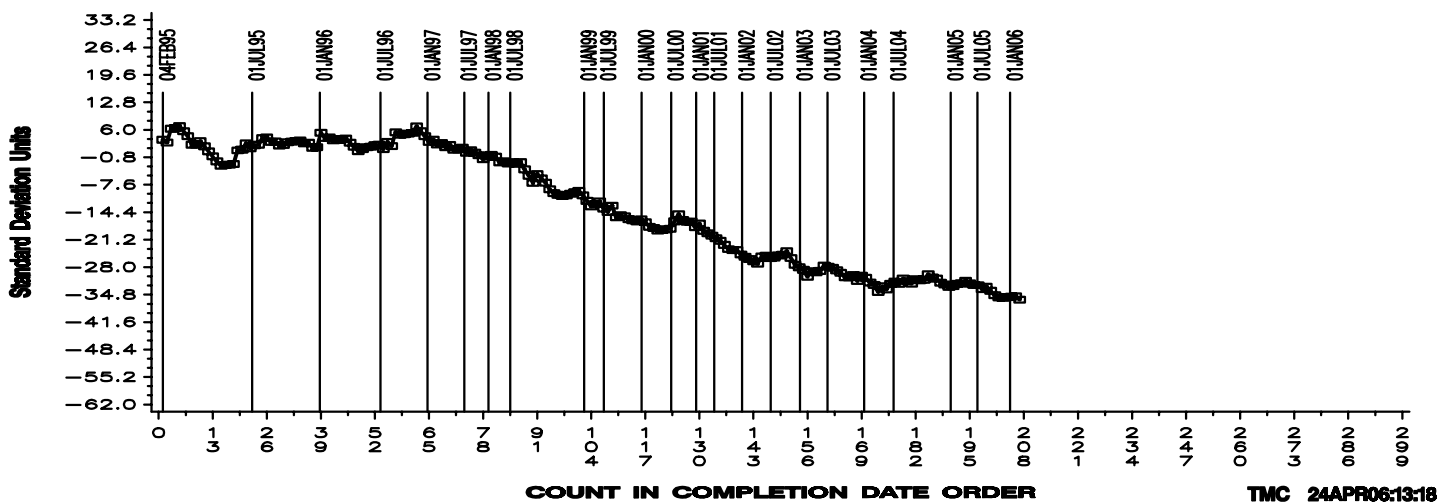
LTMS Severity Analysis



LTMS Precision Analysis



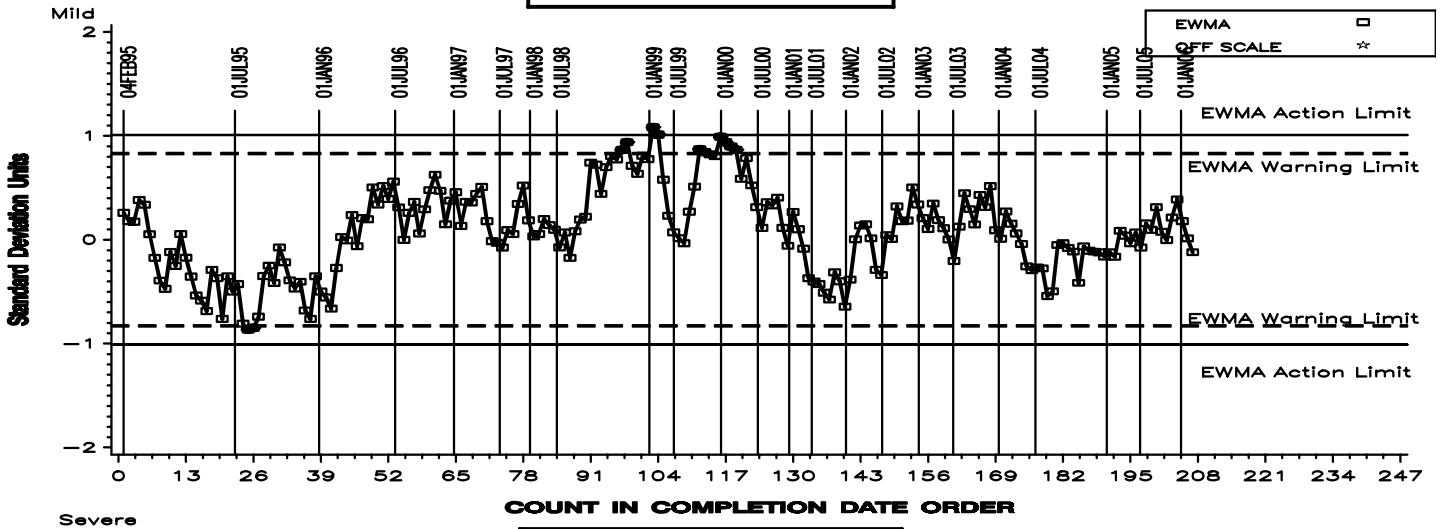
CUSUM Severity Analysis



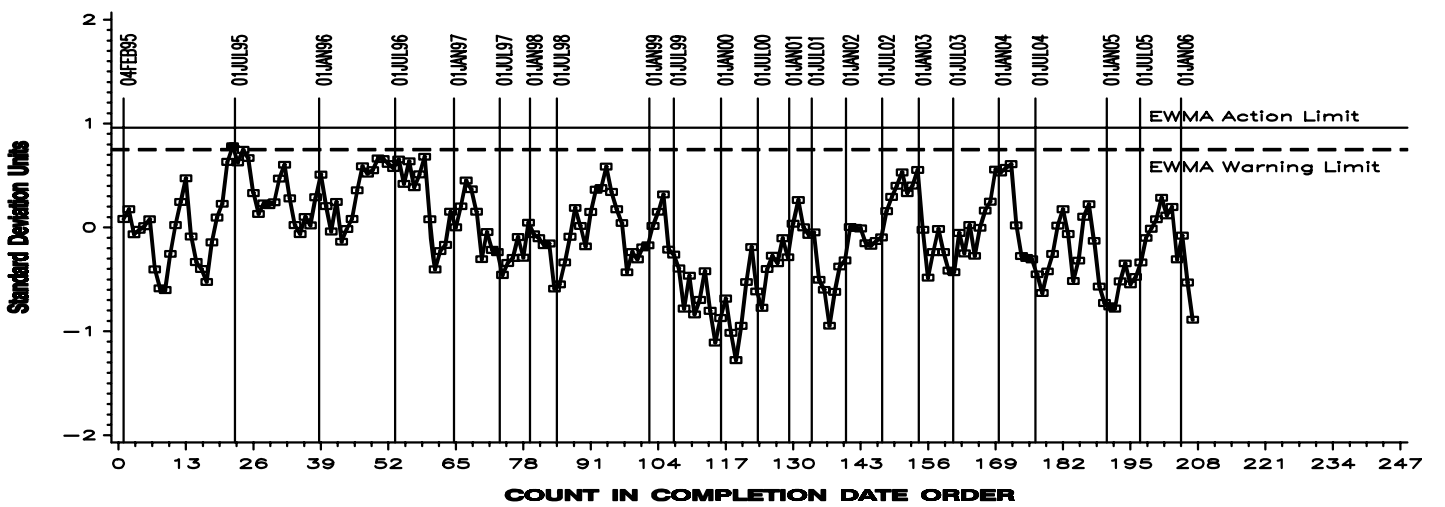
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIDGING

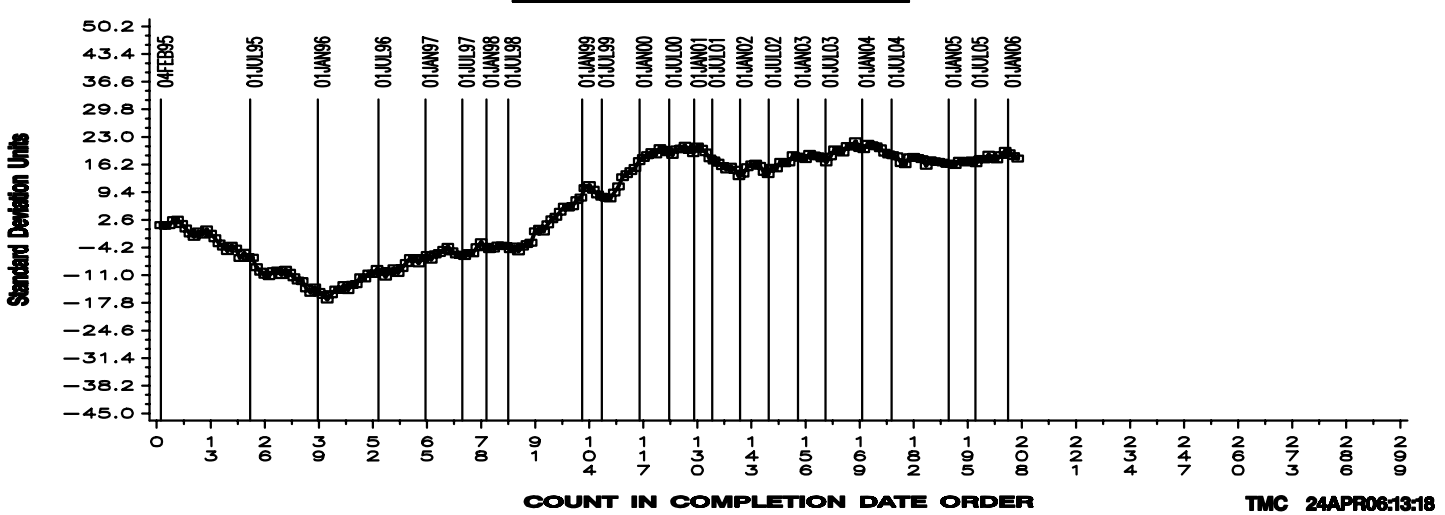
LTMS Severity Analysis



LTMS Precision Analysis



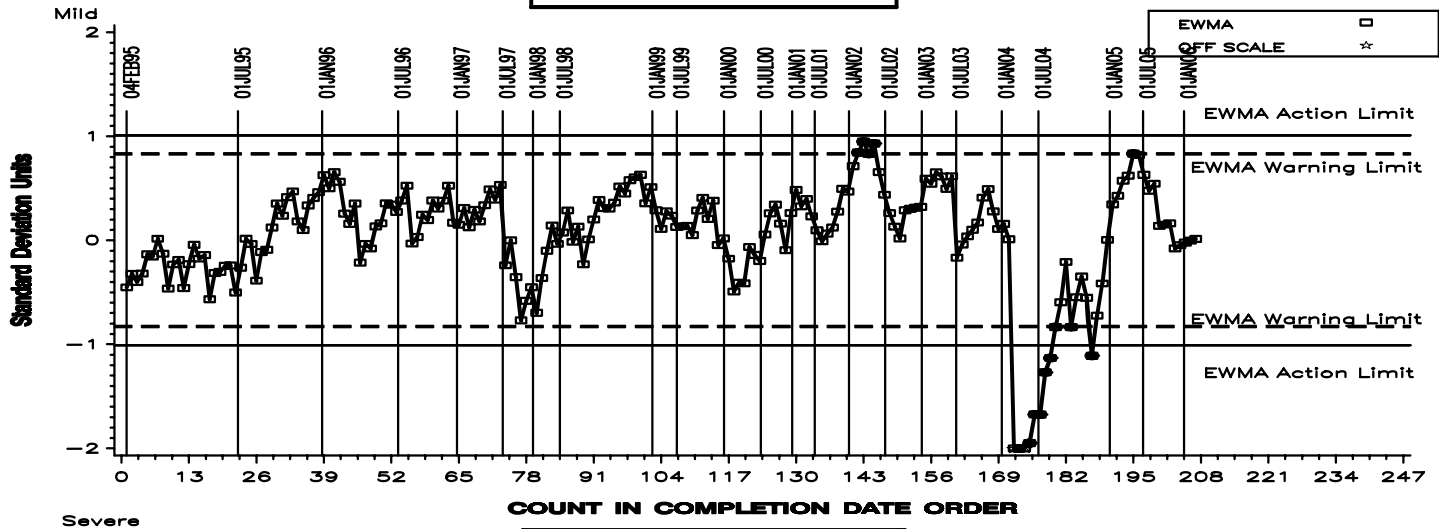
CUSUM Severity Analysis



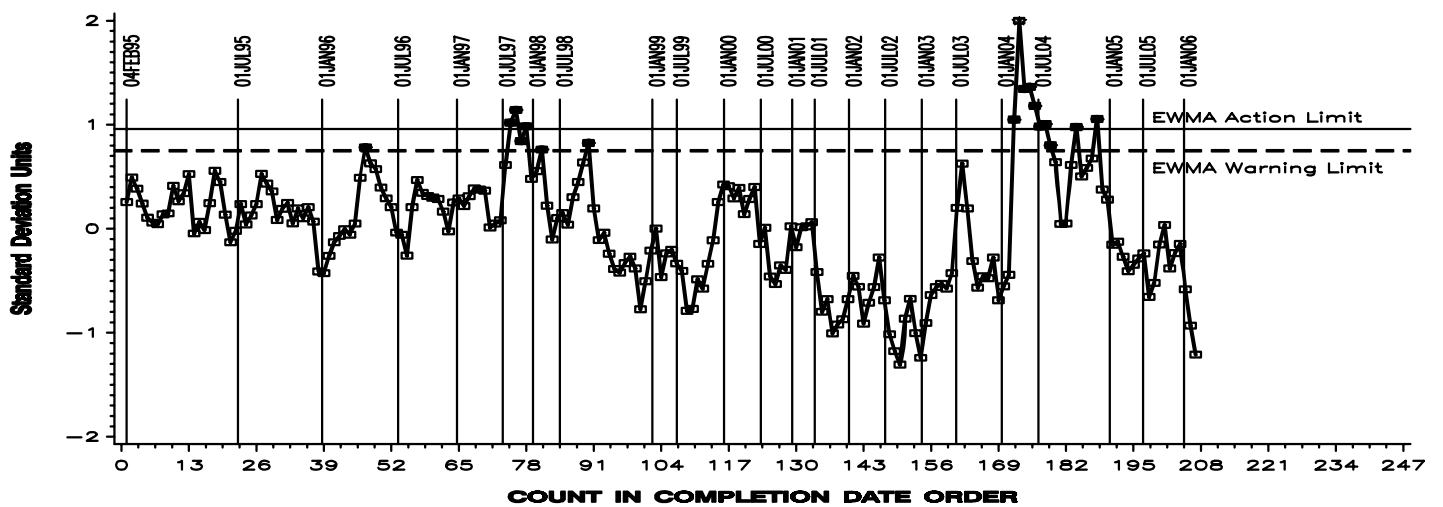
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR PITTING/SPALLING

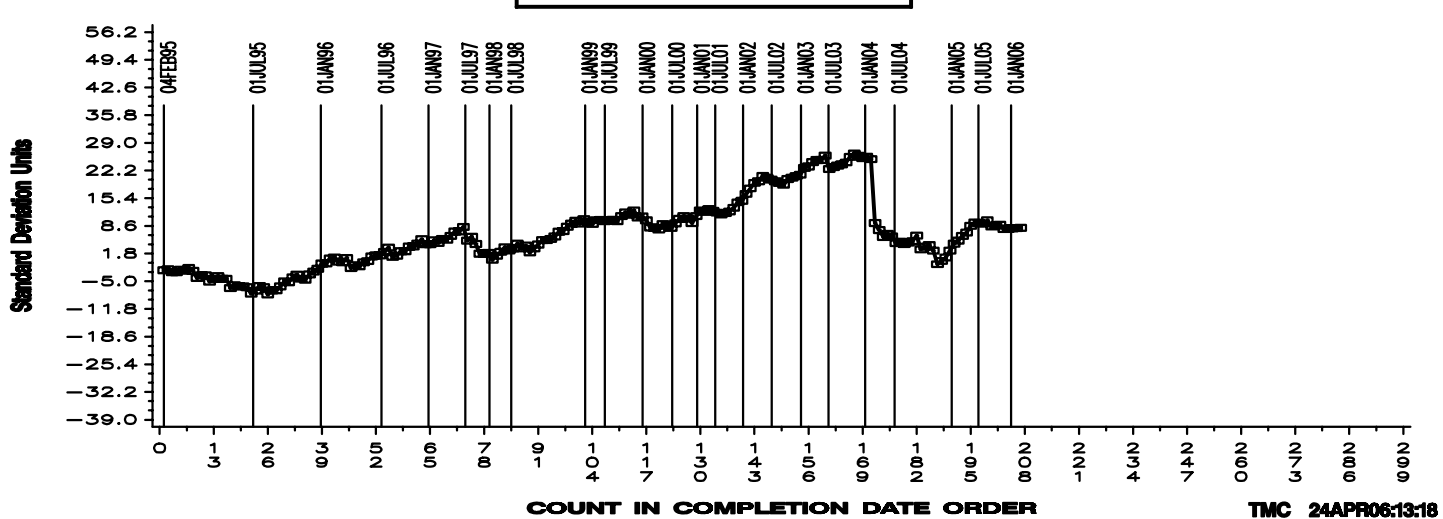
LTMS Severity Analysis



LTMS Precision Analysis



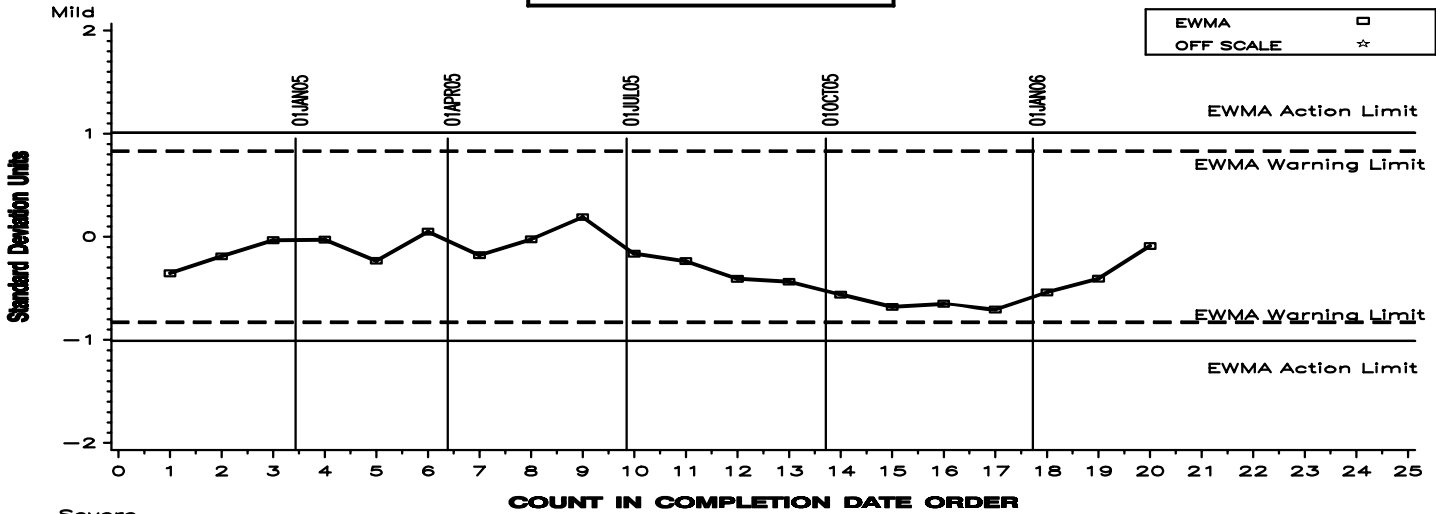
CUSUM Severity Analysis



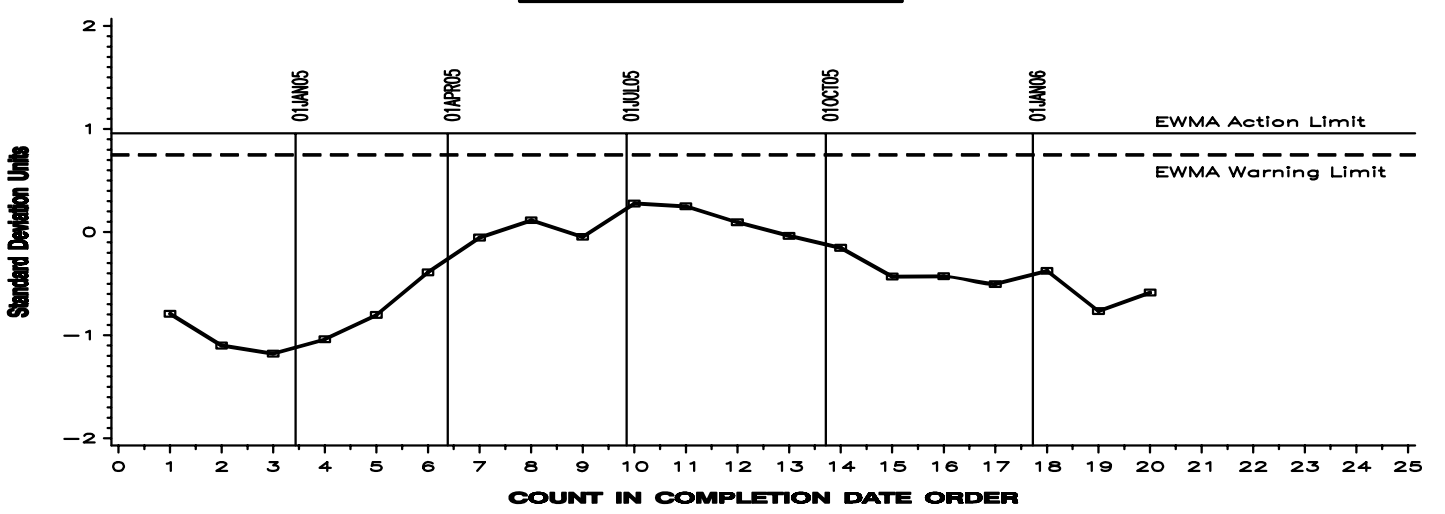
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

LAST 20 DATA POINTS FINAL PINION GEAR WEAR

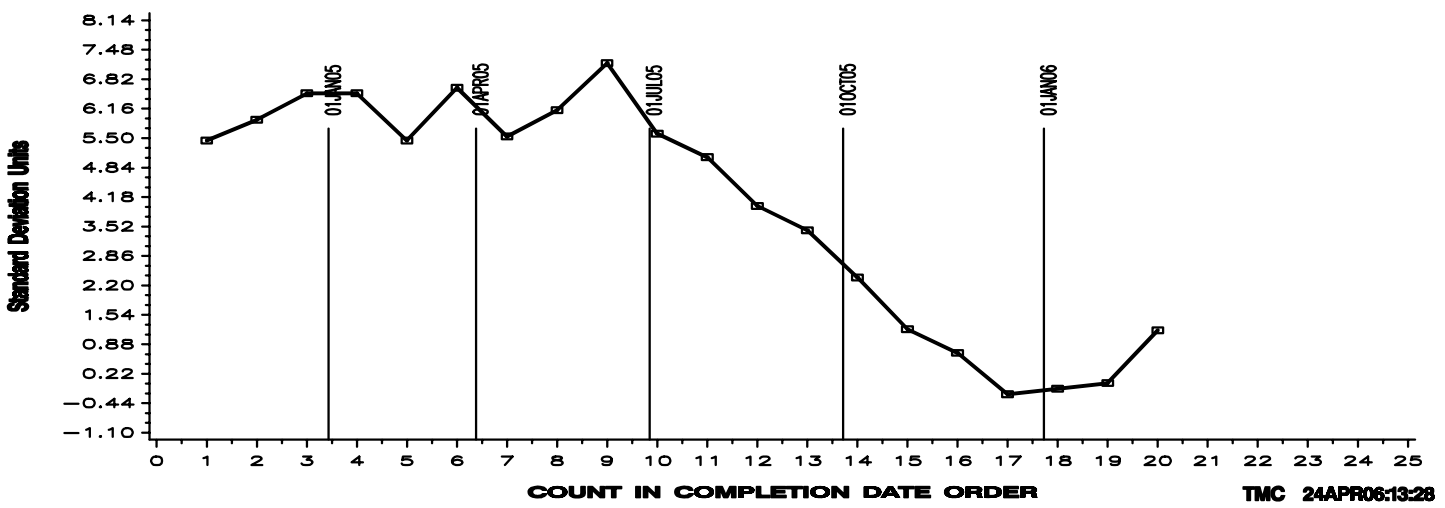
LTMS Severity Analysis



LTMS Precision Analysis



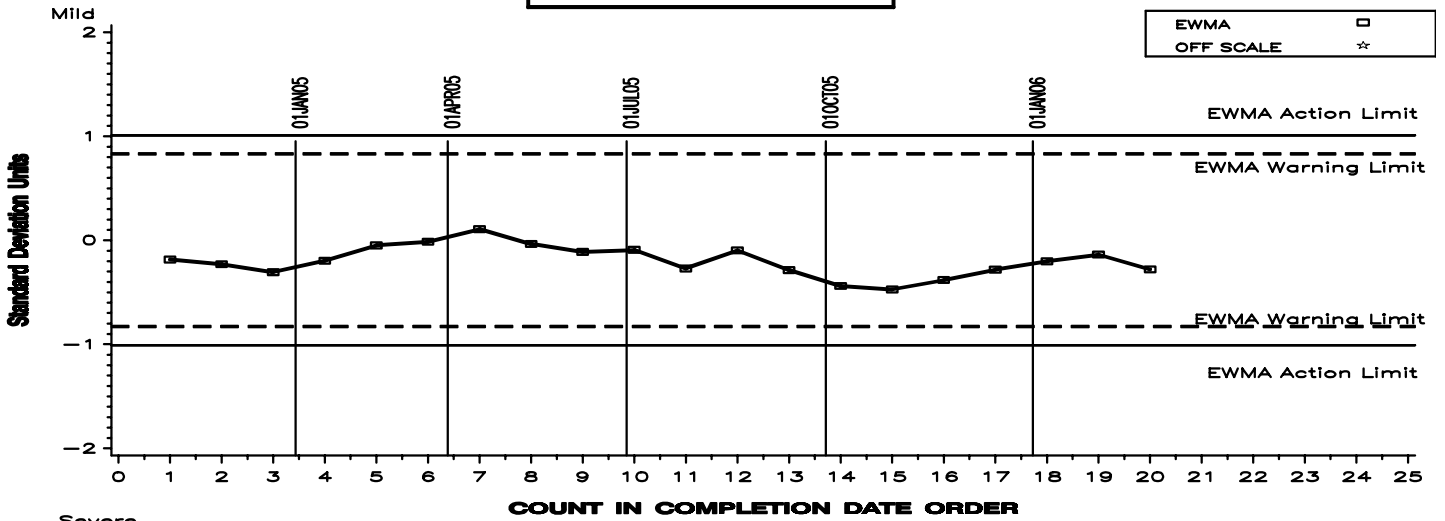
CUSUM Severity Analysis



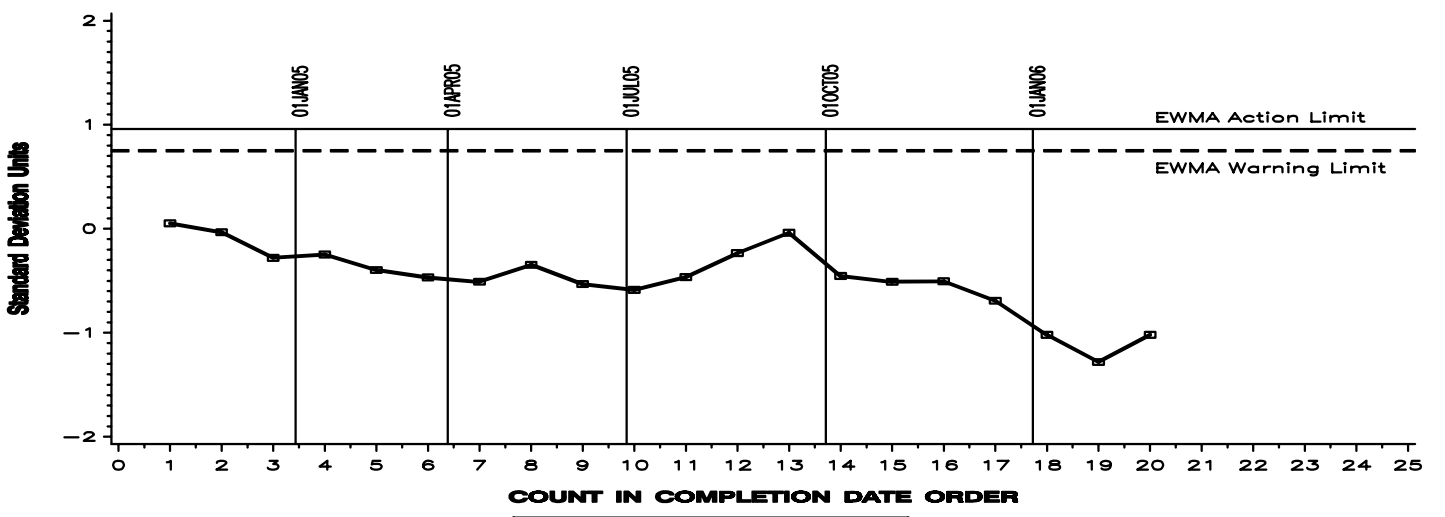
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

LAST 20 DATA POINTS FINAL PINION GEAR RIPPLING

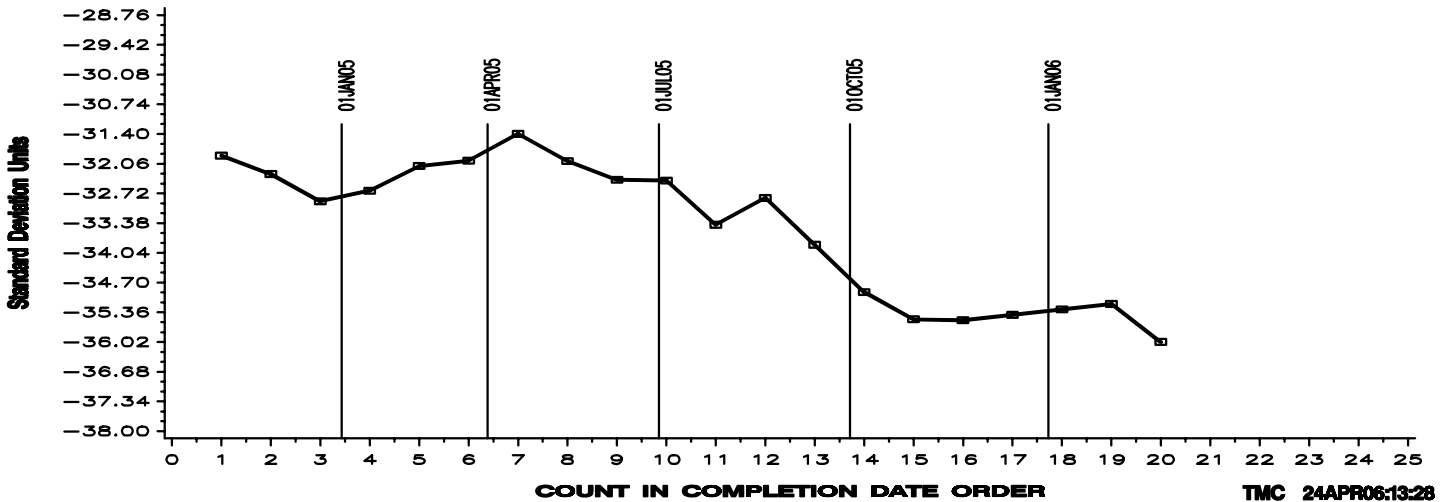
LTMS Severity Analysis



LTMS Precision Analysis



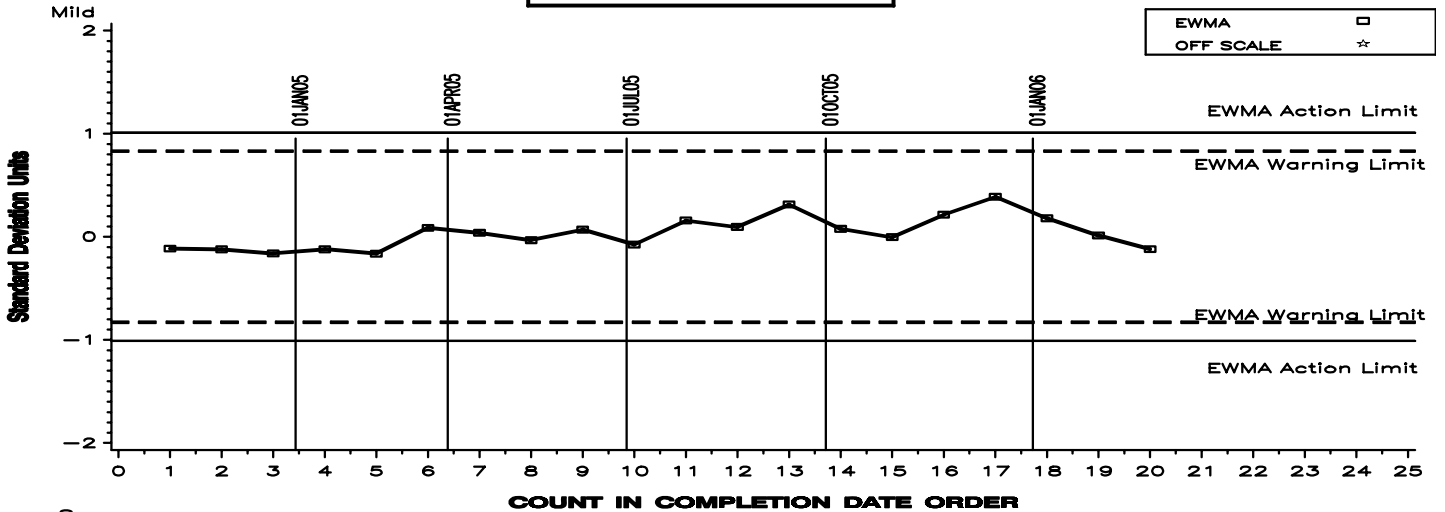
CUSUM Severity Analysis



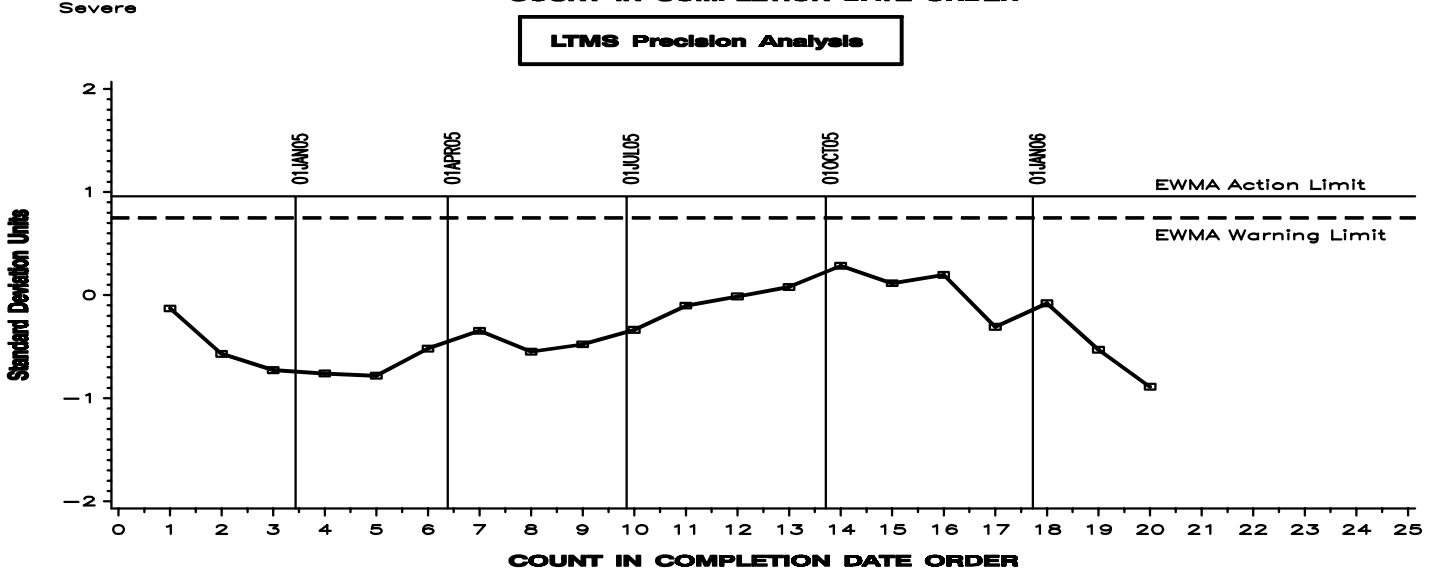
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

LAST 20 DATA POINTS FINAL PINION GEAR RIDGING

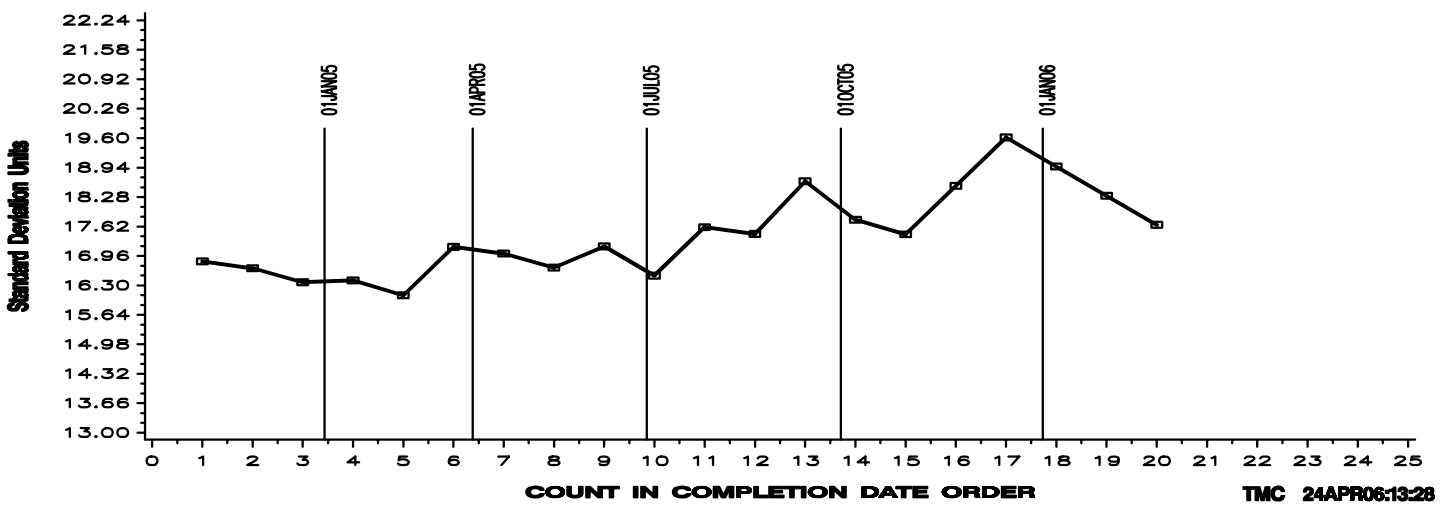
LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

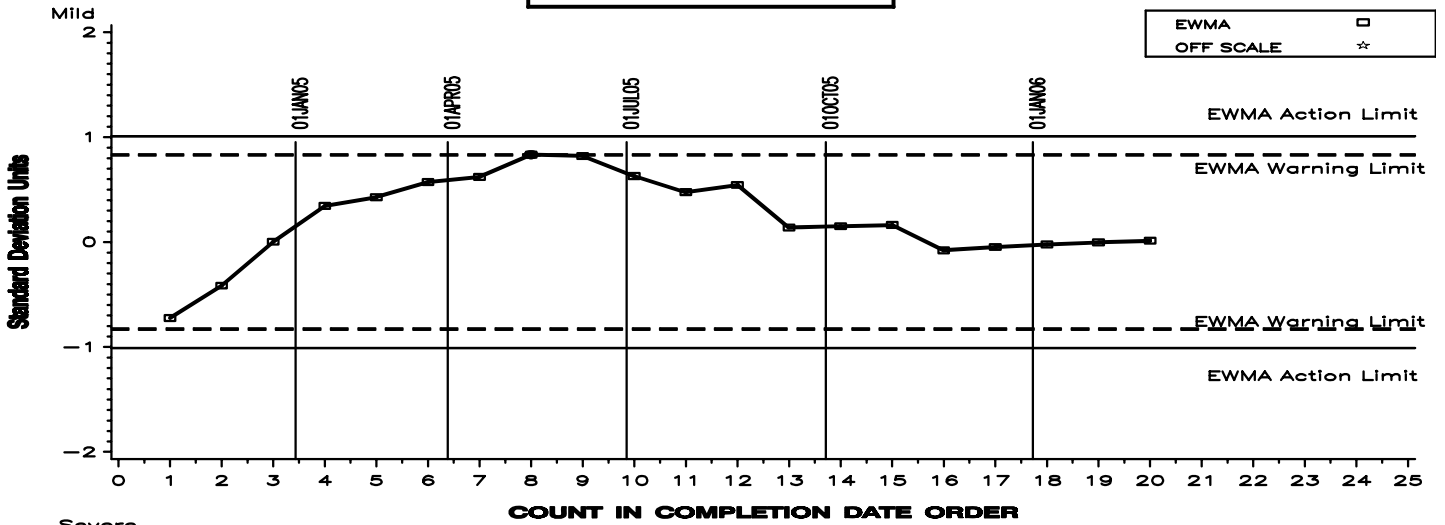


L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

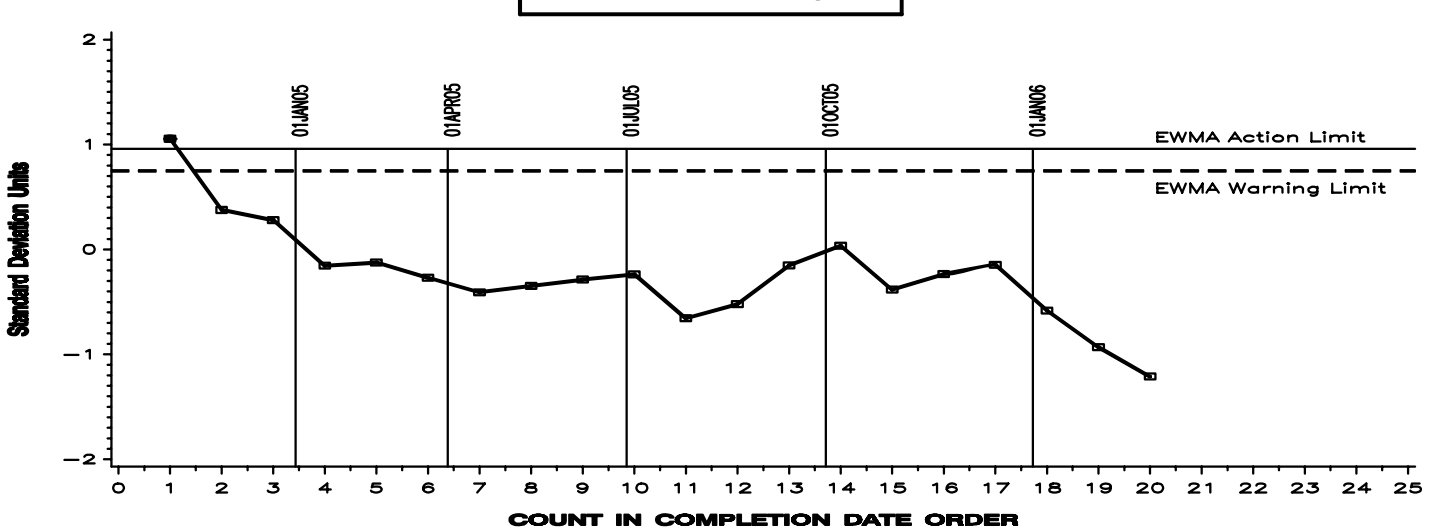
LAST 20 DATA POINTS

FINAL PINION GEAR PITTING/SPALLING

LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

