



Test Monitoring Center

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Pittsburgh, PA 15206-4489
(412) 365-1000

MEMORANDUM: 05-019

DATE: April 19, 2005

TO: Don Bartlett, Chairman, L-37 Surveillance Panel

FROM: Donald Lind

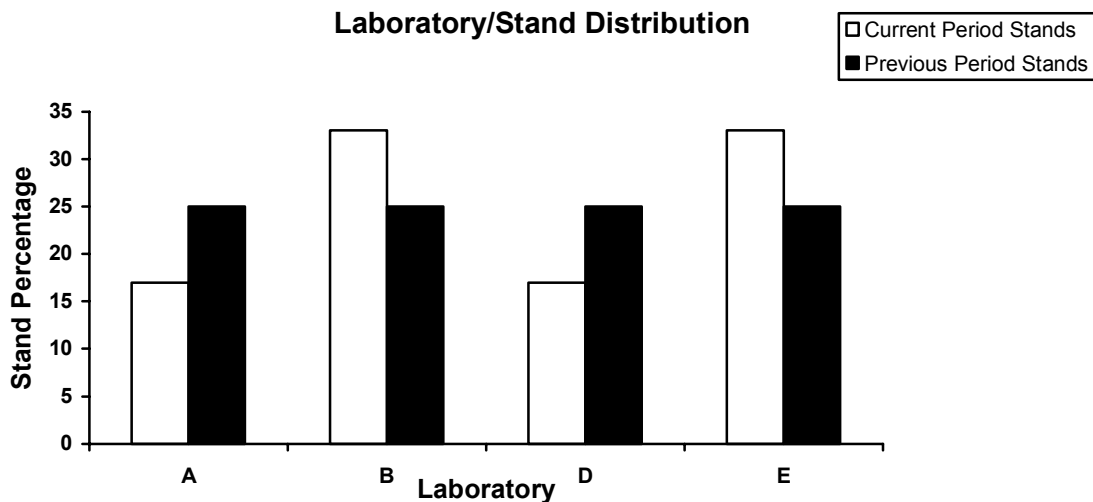
SUBJECT: L-37 Reference Test Status from October 1, 2004 through March 31, 2005

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, 2004 through March 31, 2005.

Lab/Stand Distribution

	Reporting Data	Calibrated as of 3/31/05
Number of Laboratories	4	4
Number of Stands	6	5

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	18
Failed Acceptance Criteria	OC	5
Operationally Invalid (Lab Judgment)	LC	1
Not Acceptable For Intended Purpose	MC	0
Aborted	XC	2
Total		26

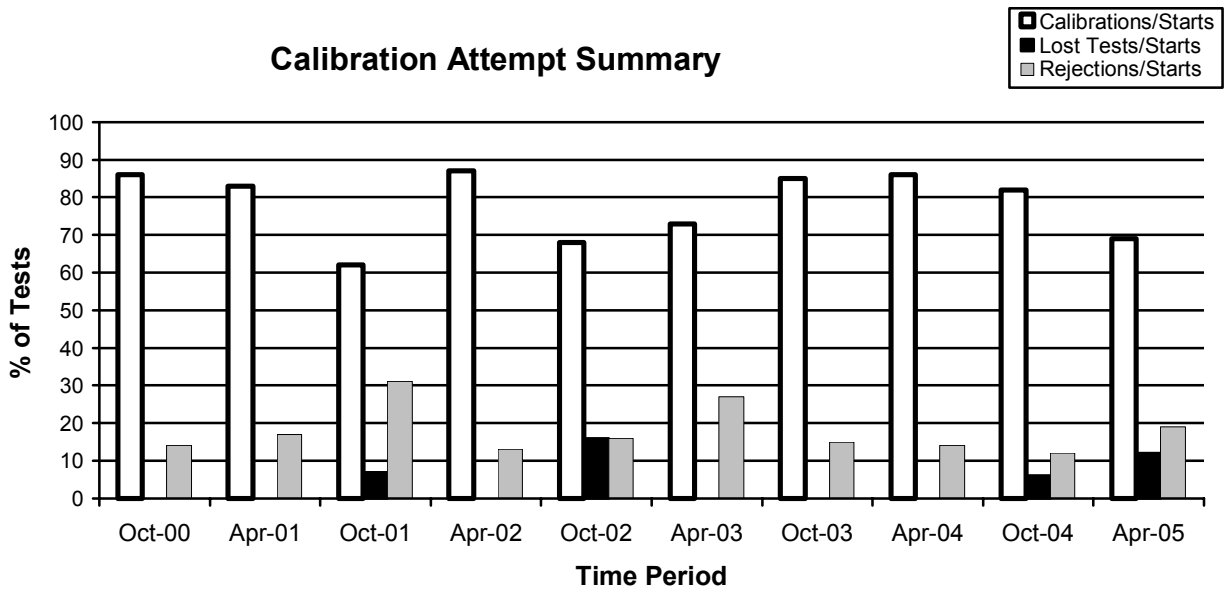
The following summarizes the acceptable and failed acceptance criteria tests by gear batch:

	Gear Batch	n-size	Acceptable	Failed Acceptance Criteria
Lubrited	V1L303/P4L514A	1	1	0
	C1L308/P4L309R	3	3	0
	V1L686/P4L626A	8	7	1
	Total	12	11	1
Non-Lubrited	V1L303/P4L514A	1	1	0
	V1L176/P4L741A	3	3	0
	C1L426/P4L415A	2	1	1
	C1L308/P4L318R	3	0	3
	V1L351/P4T771	2	2	0
	Total	11	7	4

Additional Tests

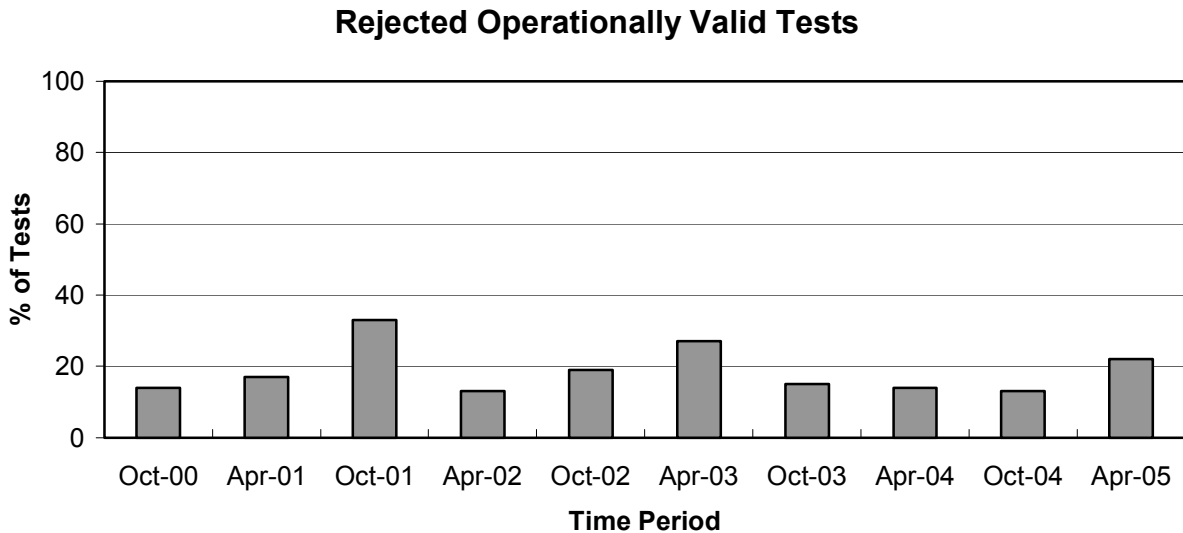
There were 47 additional tests conducted this report period. 41 tests were conducted to evaluate new non-lubrited hardware, gear batch V1L351/P4L771 and six tests were conducted to evaluate the new lubrited hardware, gear batch L247/T758A.

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



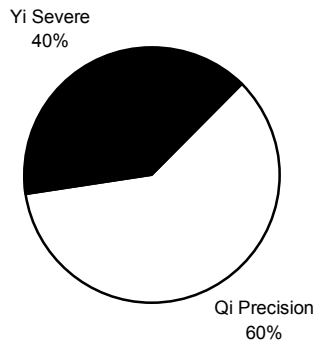
The lost test per start rate and the rejected per start rate have increased with respect to the previous period. The calibration per start rate has decreased with respect to the previous period.

The operationally valid statistically rejected test rate, as shown below, indicates an increase with respect to the previous period.

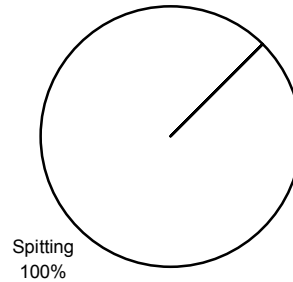


A detailed list of reasons tests failed the acceptance criteria is shown in Table 1. The following charts summarize these reasons with a breakdown by parameter of the failed tests.

Distribution of LTMS Stand Alarms



Distribution of Stand Alarms by Parameter



There were no LTMS deviations written this period.

Severity and Precision

The mean Δ/s by gear batch, overall mean Δ/s , and shift in merits for the operationally and statistically 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 2.

LUBRICATED HARDWARE						
Parameter	Gear Batch	N	Δ/s	s^D	Overall Δ/s	Overall Shift In Merits
Wear	V1L686/P4L626A	8	0.07	0.79	0.08	0.10 ^C
	C1L308/P4L309R	3	0.06	0.50		
	V1L303/P4L514A	1	0.27	----		
Ridging	V1L686/P4L626A	8	-0.40	0.58	-0.20	-0.19 ^{A, C}
	C1L308/P4L309R	3	0.16	0.00		
	V1L303/P4L514A	1	0.81	----		
Rippling	V1L686/P4L626A	8	-0.457	1.01	-0.38	-0.29 ^{A, C}
	C1L308/P4L309R	3	-0.54	0.67		
	V1L303/P4L514A	1	0.80	----		
Pitt/Spall	V1L686/P4L626A	8	-0.27	0.66	0.07	0.06 ^{B, C}
	C1L308/P4L309R	3	0.56	0.49		
	V1L303/P4L514A	1	1.38	----		

^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-LUBRITED HARDWARE						
Parameter	Gear Batch	N	Δ/s	s^D	Overall Δ/s	Overall Shift In Merits
Wear	C1L308/P4L318R	3	-0.63	0.00	-0.17	-0.13 ^C
	C1L426/P4L415A	2	0.47	0.00		
	V1L176/P4L741A	3	-0.34	0.81		
	V1L303/P4L514A	1	0.00	----		
	V1L351/P4T771	2	0.06	1.58		
Ridging	C1L308/P4L318R	3	-0.26	0.00	-0.08	-0.02 ^{A,C}
	C1L426/P4L415A	2	-0.15	0.00		
	V1L176/P4L741A	3	-0.20	1.47		
	V1L303/P4L514A	1	0.04	----		
	V1L351/P4T771	2	0.38	1.00		
Rippling	C1L308/P4L318R	3	-0.13	0.27	-0.09	-0.13 ^{A,C}
	C1L426/P4L415A	2	-0.74	0.47		
	V1L176/P4L741A	3	-0.01	1.17		
	V1L303/P4L514A	1	0.24	----		
	V1L351/P4T771	2	0.33	0.30		
Pitt/Spall	C1L308/P4L318R	3	-2.02	2.27	-0.01	0.00 ^{B,C}
	C1L426/P4L415A	2	0.82	0.00		
	V1L176/P4L741A	3	0.25	1.53		
	V1L303/P4L514A	1	1.71	----		
	V1L351/P4T771	2	0.96	0.27		

^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. Severity and precision EWMA charts for pinion Wear, Ridging, Rippling, and Pitting/Spalling were in control this report period.

Non-lubrited

Figures 5 through 8 are the non-lubrited industry control charts for pinion Wear, Rippling, Ridging, and Pitting/Spalling, respectively. Severity and precision EWMA charts for pinion Wear, Ridging, and Rippling were in control this report period. Pitting/Spalling triggered one severity EWMA action alarm, one severity EWMA warning alarm, and two precision EWMA action alarms. The alarms were influenced by two test results, three standard deviations severe each. Both results were from the same lab.

TMC Lab Visits

There were three lab visits this report period with several discrepancies to report. The discrepancies are listed below:

1. The cover plate spray nozzle was not $9 \frac{1}{4}$ inches from the cover plate as specified in Figure A5.1
2. During the first two minutes of the Gear Test Phase of the test the wheel r/min was out of specification.
3. The right rear cover plate nozzle did not comply with the specifications of $2 \pm 1/2$ inch from the drive shaft centerline and the $60 \pm 5^\circ$ from the axle shaft centerline.
4. The top nozzle did not comply with the specifications of $7 \frac{1}{8} \pm 1/2$ inch from the rear flange cover mating surface and the $8 \frac{3}{4} \pm 1/2$ inch from axle centerline.
5. There was no documentation to verify that the dynamometer connecting shafts were dynamically balanced as outlined in Section 6.2.7.
6. The top spray nozzle was not $8 \frac{3}{4}$ inches $\pm \frac{1}{2}$ inch from the axle centerline as specified in Figure A5.1.
7. The spray nozzles were not at the specified 45° and 60° angles as specified in Figure 5A.
8. 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.
9. The control valves were not using a type C, linear trim packaged as specified in Section 6.2.4.3.2.
10. There was no locking pin or stop block as specified in Section 6.2.4.3.6.
11. The drive shaft wall thickness and balancing specification could not be verified as specified in Section 6.2.8

Information Letters

There were two information letters issued this report period. Information Letter 04-03, Sequence Number 32 was issued on December 2, 2004 and Information Letter 05-01, Sequence Number 33 was issued on February 18, 2005. Items changed with these information letters are documented in the L-37 timeline (Table 3).

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	2	1	2	3	16
128-1	4	5	3	5	21
128-2	4	3	5	2	256
151-2	2	0	1	3	*
151-3	3	4	7	6	**
152	6	9	5	6	44
152-1	0	0	0	0	165
153	6	9	3	6	46
153-1	0	0	0	0	156

* 0 Gallons (Multiple test area usage)

** 108 Gallons (Multiple test area usage)

DML/dml

Attachments

c: <ftp://ftp.astmtmc.cmu.edu/docs/gear/137/semiannualreports/137-04-2005.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 is the Severity Summary for This Report Period by Laboratory, Hardware, and Gear Batch

Table 3 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 for Pinion Wear (Non-Lubrited Hardware)

Figure 6 is the Industry Control Chart for Pinion Rippling (Non-Lubrited Hardware)

Figure 7 is the Industry Control Chart for Pinion Ridging (Non-Lubrited Hardware)

Figure 8 is the Industry Control Chart for Pinion Pitting/Spalling (Non-Lubrited Hardware)

Table 1

Summary of Reasons for Rejected Tests

Reasons	No. of Tests
Stand Precision EWMA Alarm (Spitting)	3
Stand shewhart severity alarm (Spitting severe)	2

Table 2

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	
	C1L308/ P4L309R	----	----	----	0.06		----	----	----	0.16		----	----	----	-0.54		----	----	----	0.56
V1L303/ P4L514 A	----	----	0.27	----		----	----	0.81	----		----	----	0.80	----		----	----	1.38	----	
V1L686 P4L626 A	-0.48	0.45	0.20	----		-0.63	-0.21	-0.99	----		-0.57	-0.48	-0.13	----		-0.59	-0.05	-0.20	----	

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	
	C1L308/ P4L318 A	----	----	----	-0.63		----	----	----	-0.26		----	----	----	-0.13		----	----	----	-2.02
C1L426/ P4L415 A	----	----	----	0.47		----	----	----	-0.15		----	----	----	-0.74		----	----	----	0.82	
V1L176/ P4L741 A	-0.81	-0.11	----	----		1.33	-0.96	----	----		-0.76	0.36	----	----		-1.37	1.06	----	----	
V1L303/ P4L514 A	----	----	0.00	----		----	----	0.04	----		----	----	0.24	----		----	----	1.71	----	
V1L351/ P4T771	----	0.06	----	----		----	0.38	----	----		----	0.33	----	----		----	0.96	----	----	

Table 3

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

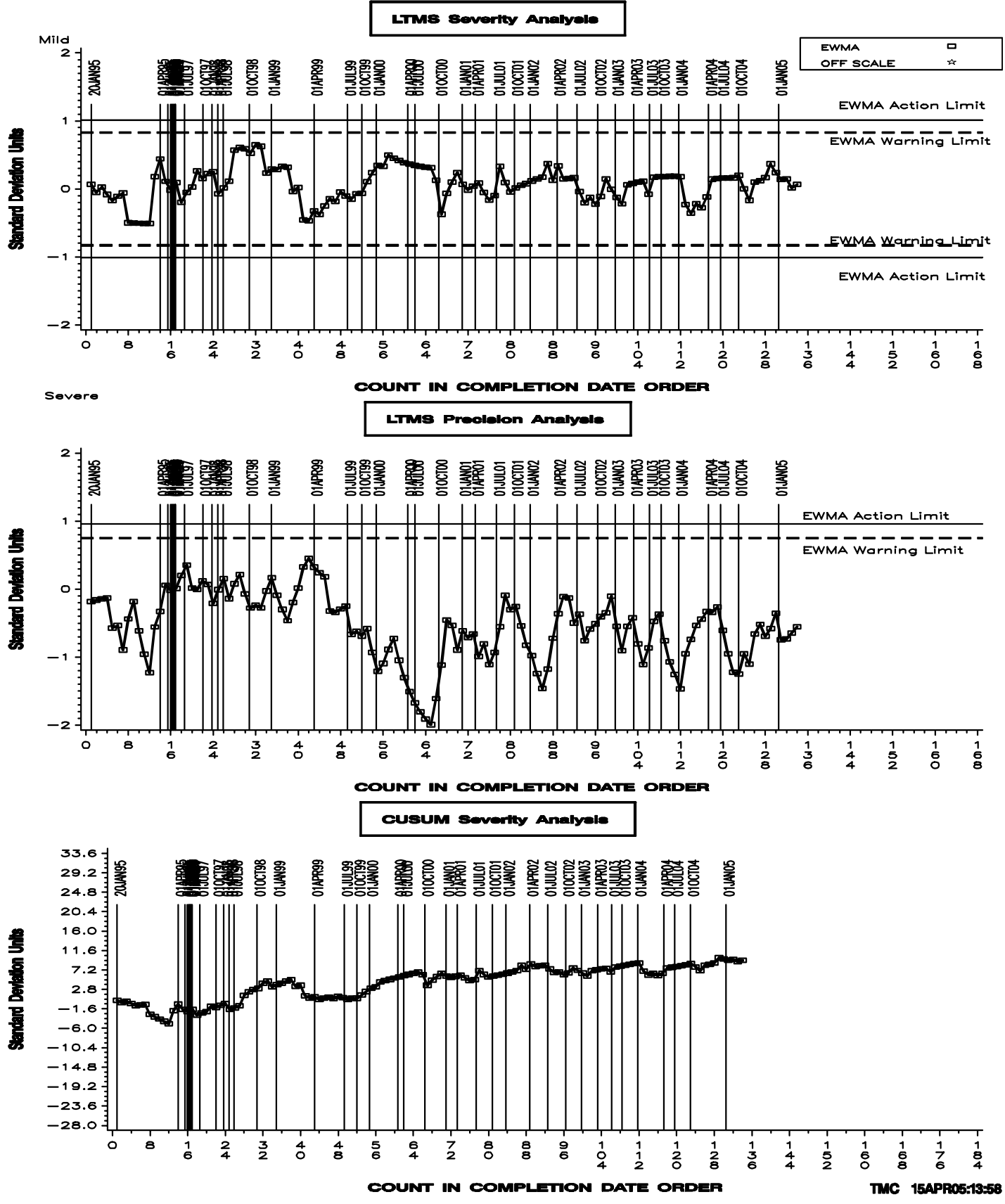
Table 3 (Continued)

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

Figure 1

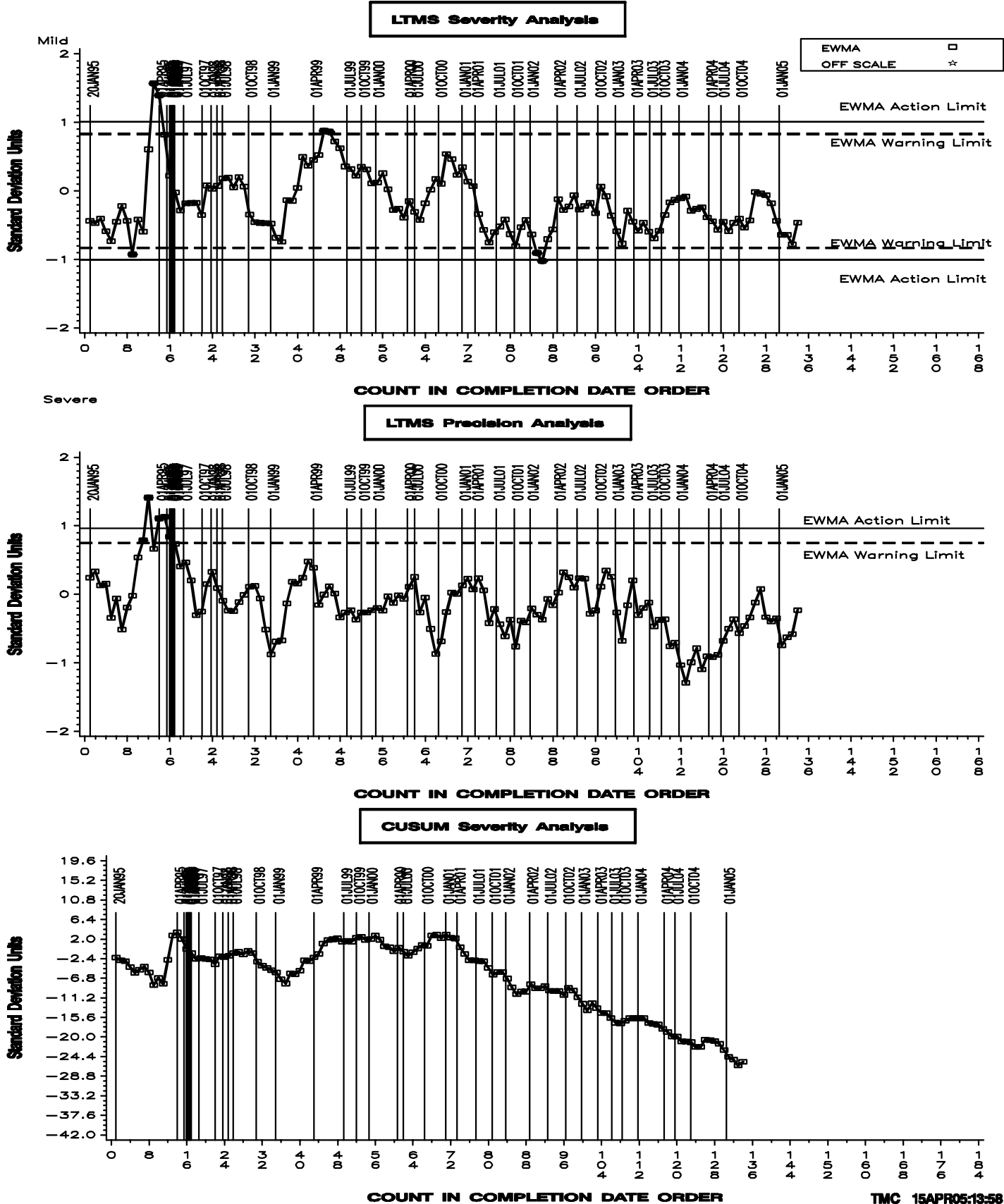
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR WEAR



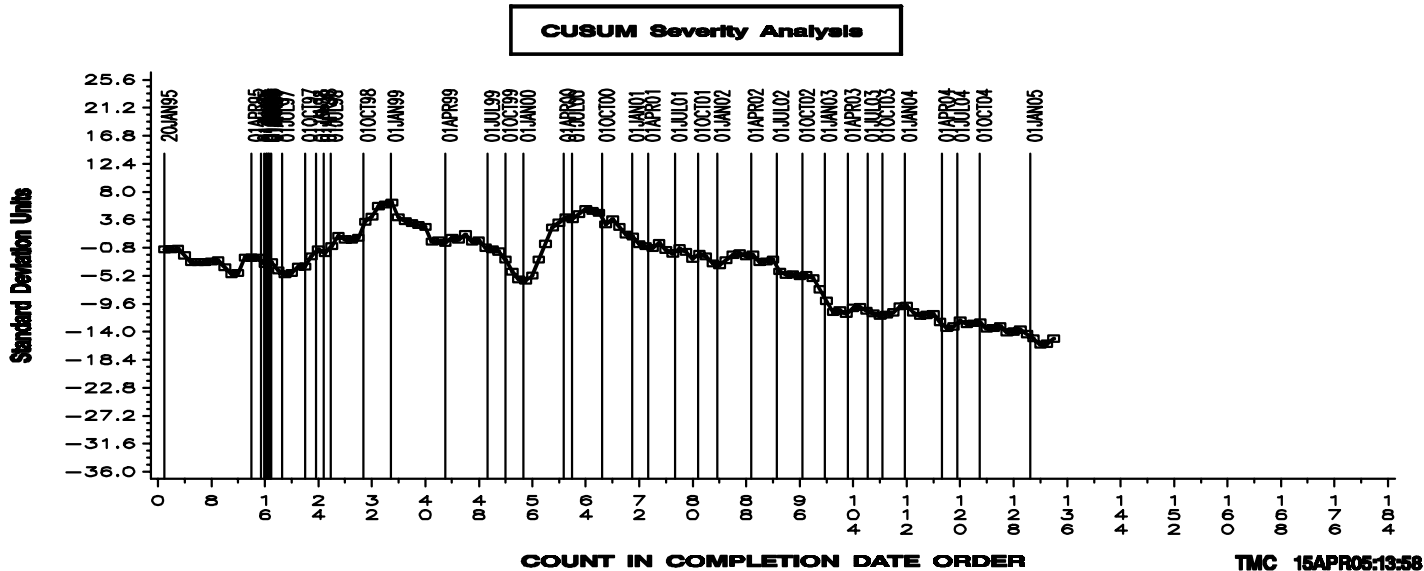
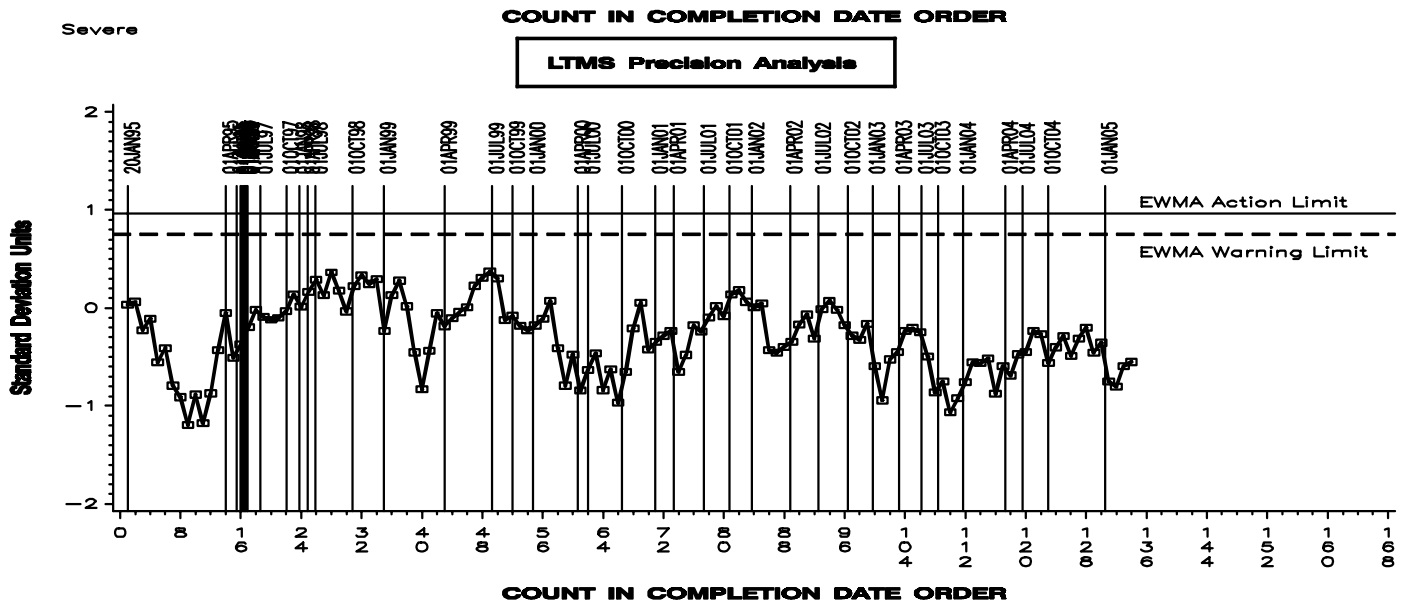
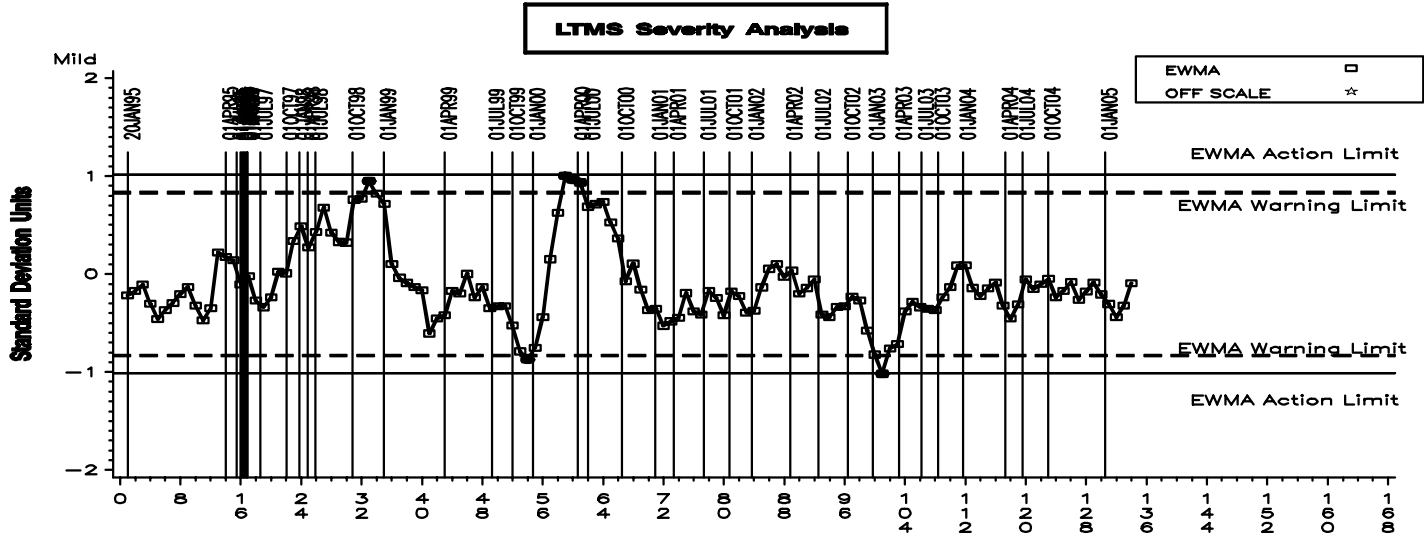
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIPPLING



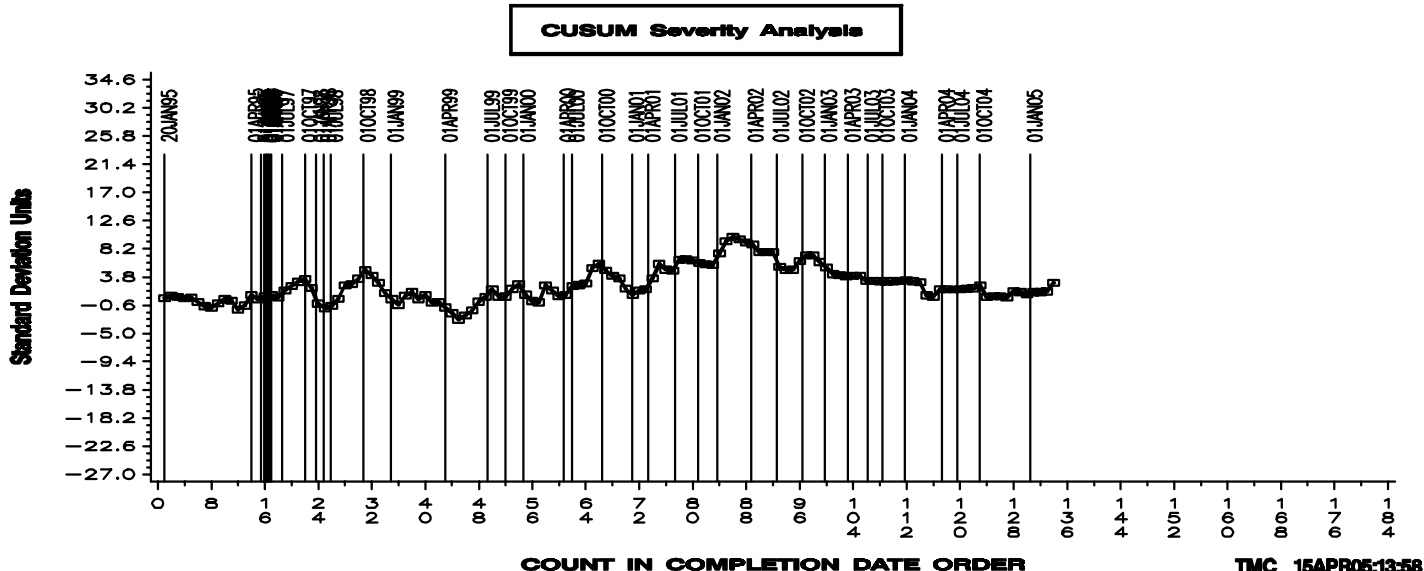
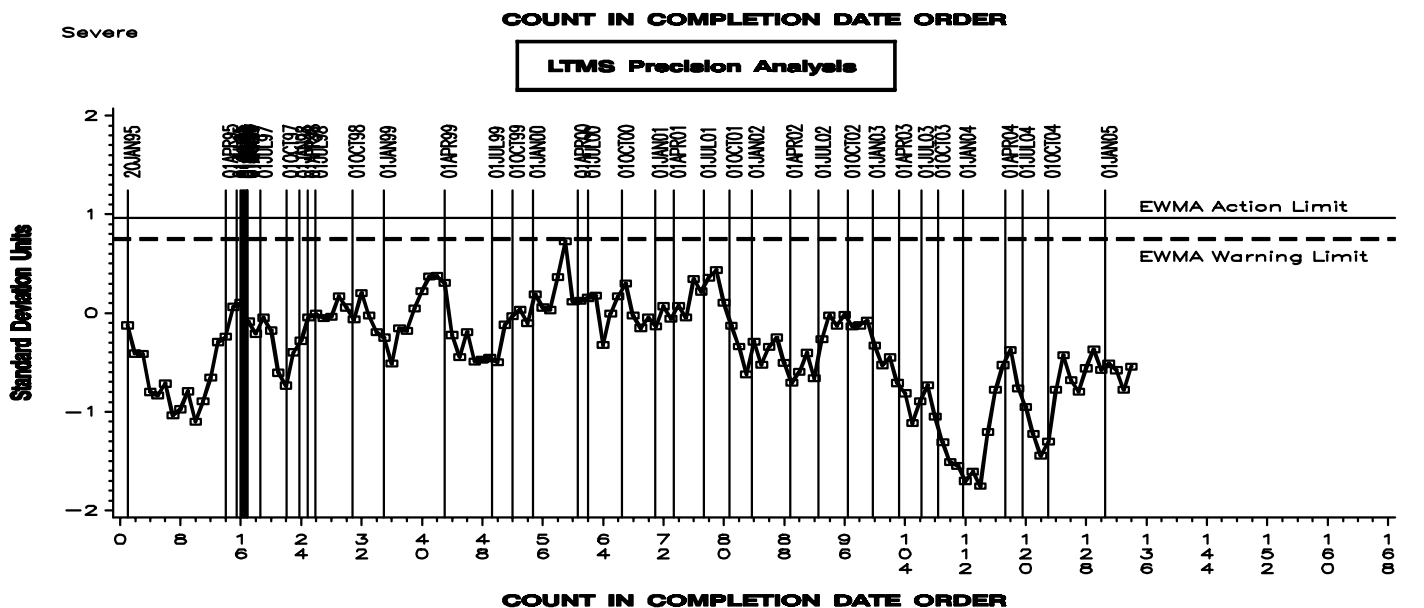
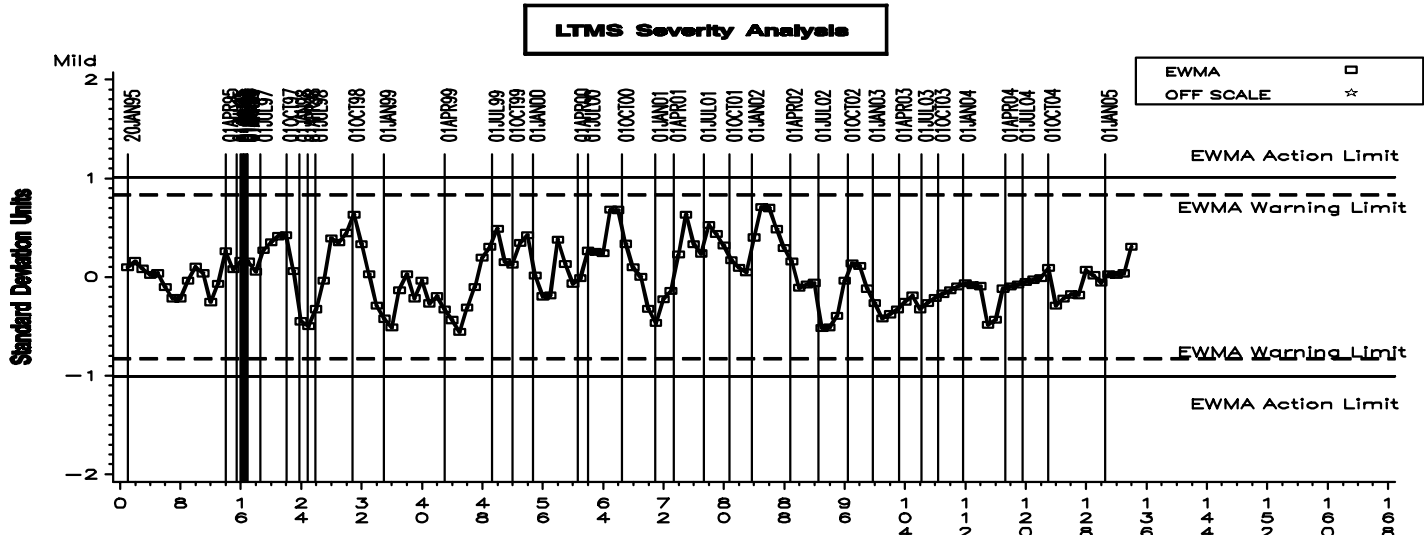
L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR RIDGING



L-37 LUBRITED INDUSTRY OPERATIONALLY VALID DATA

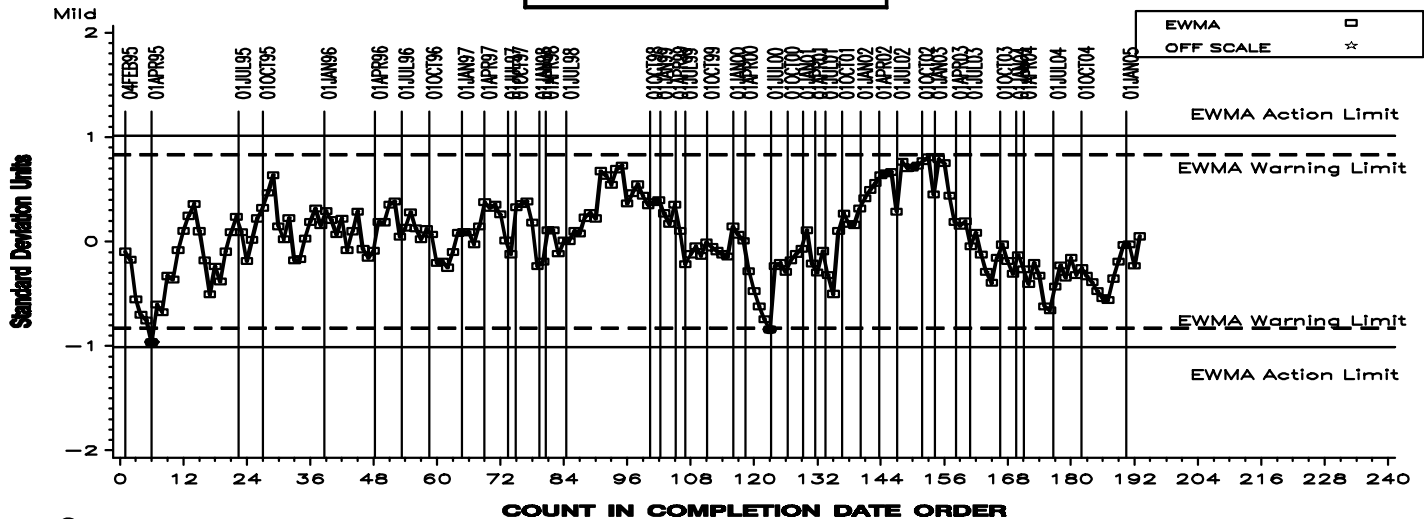
FINAL PINION GEAR PITTING/SPALLING



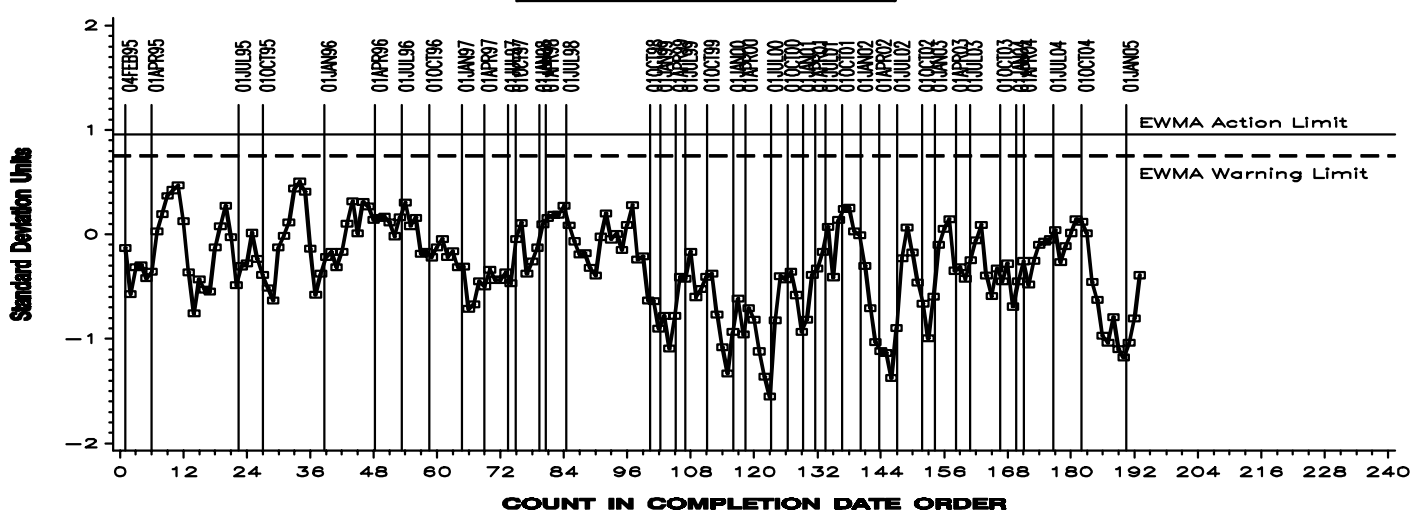
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR WEAR

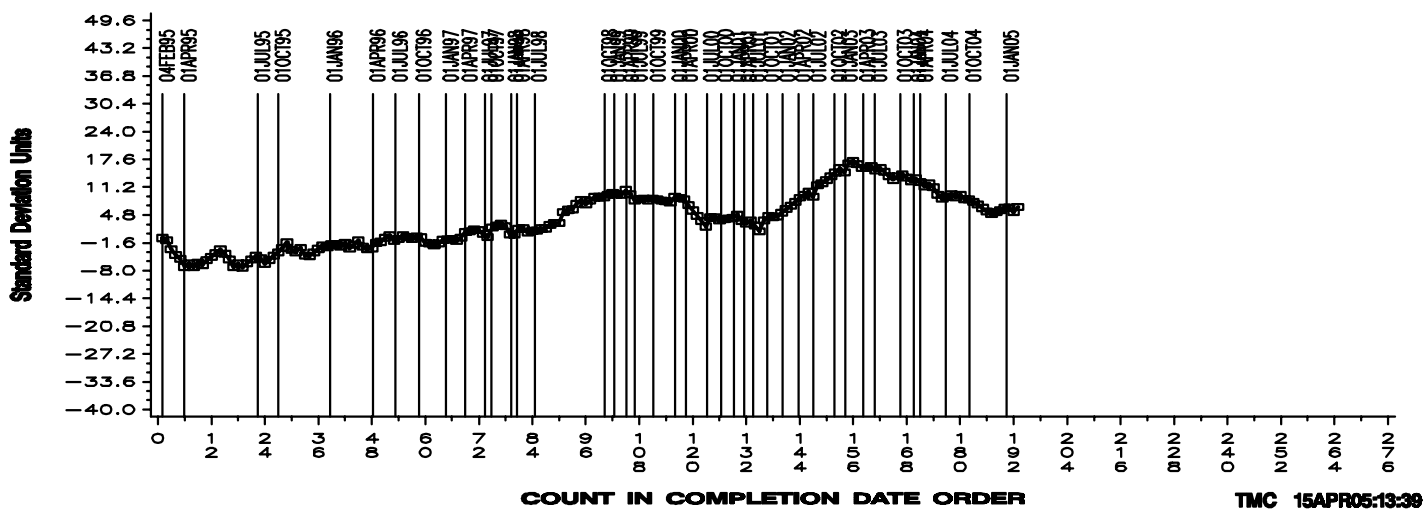
LTMS Severity Analysis



LTMS Precision Analysis



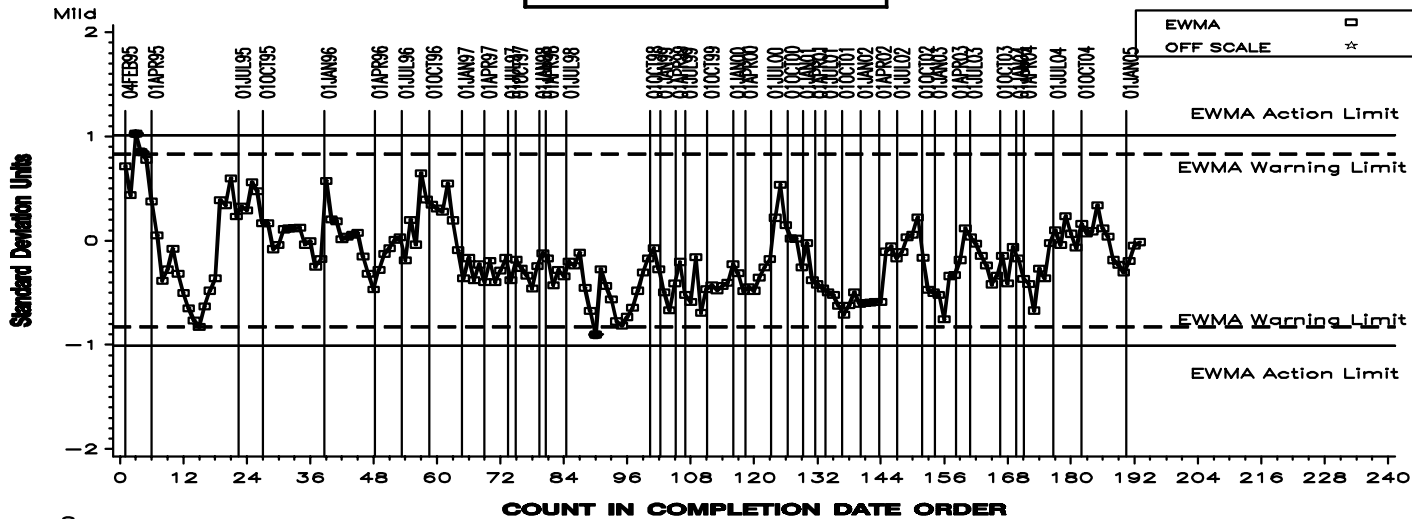
CUSUM Severity Analysis



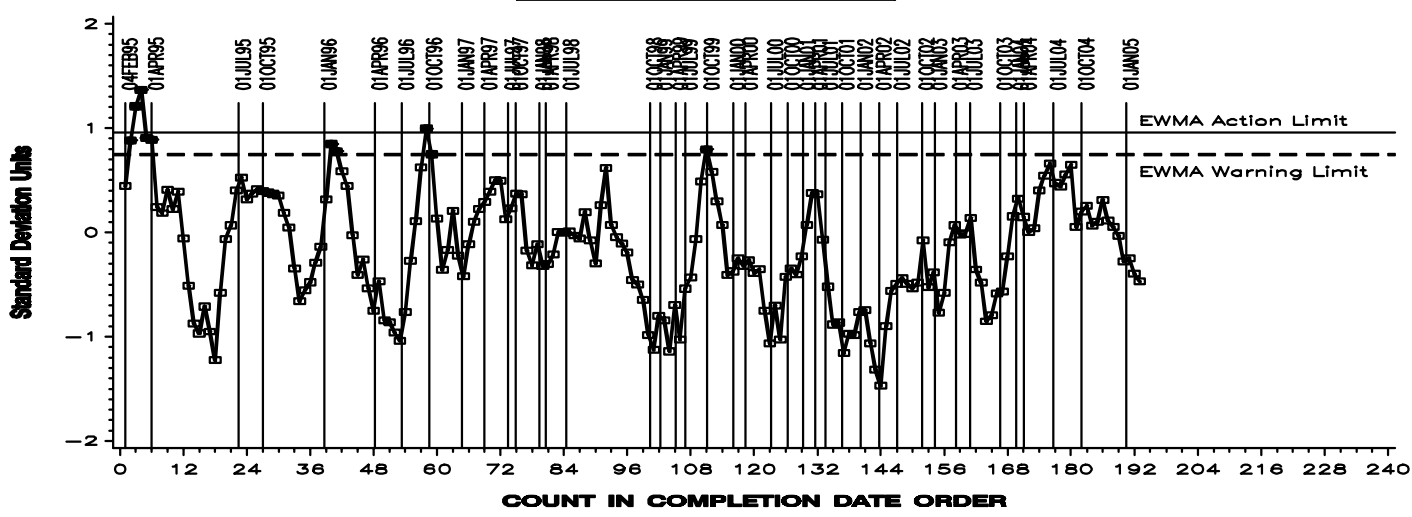
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FINAL PINION GEAR RIPPLING

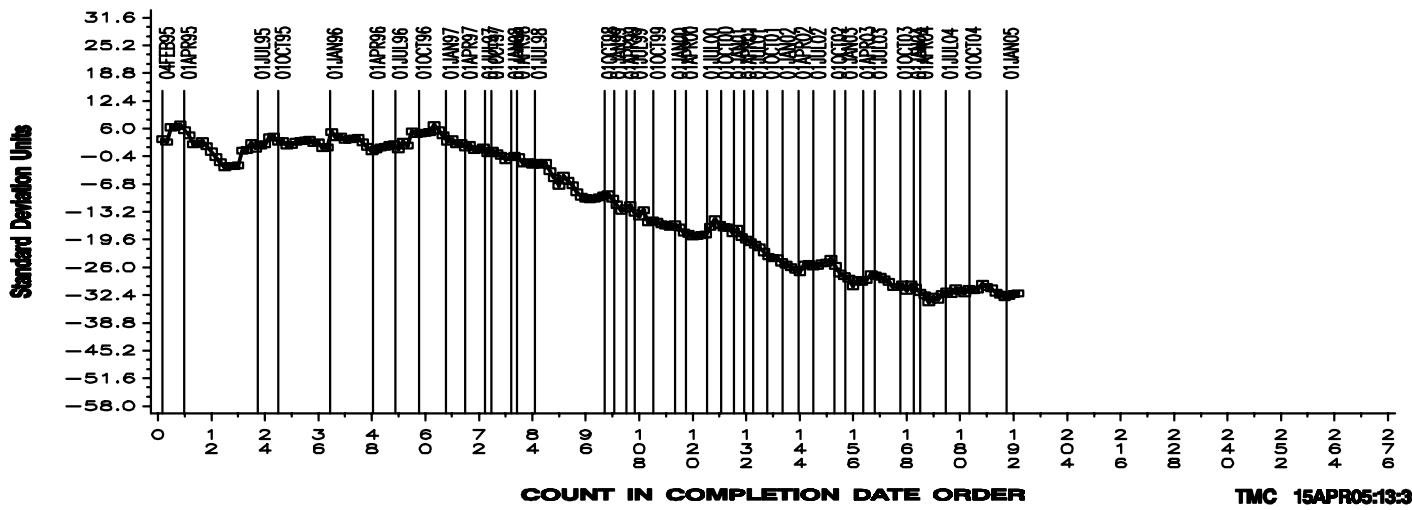
LTMS Severity Analysis



LTMS Precision Analysis

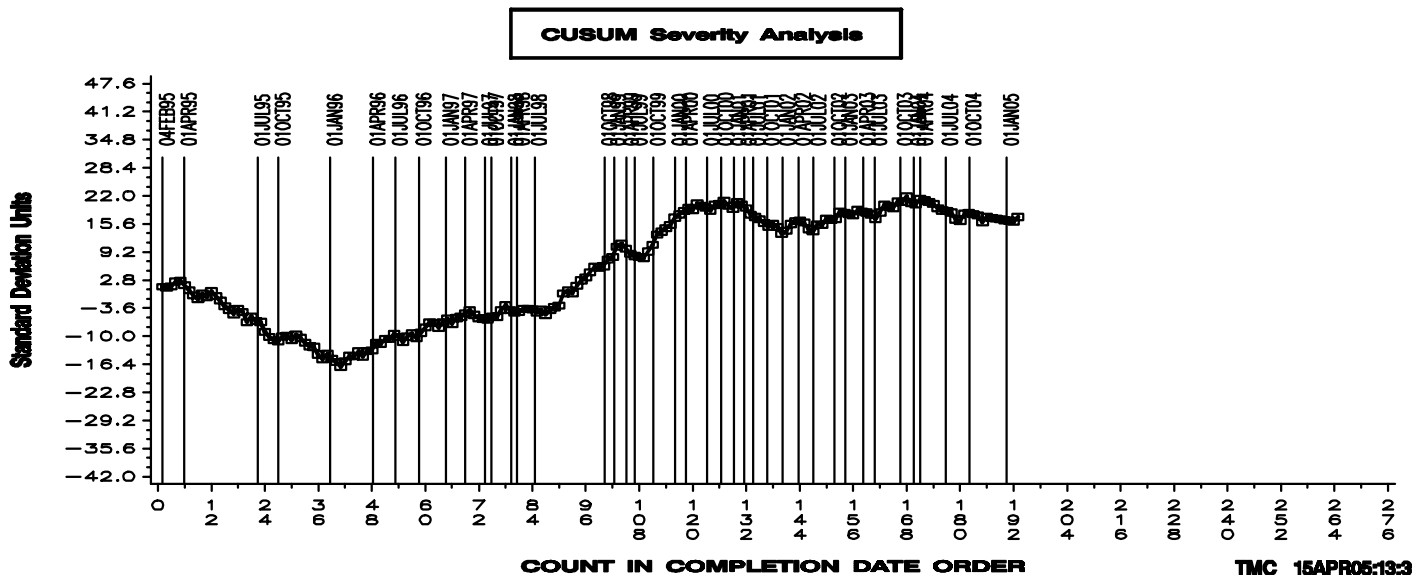
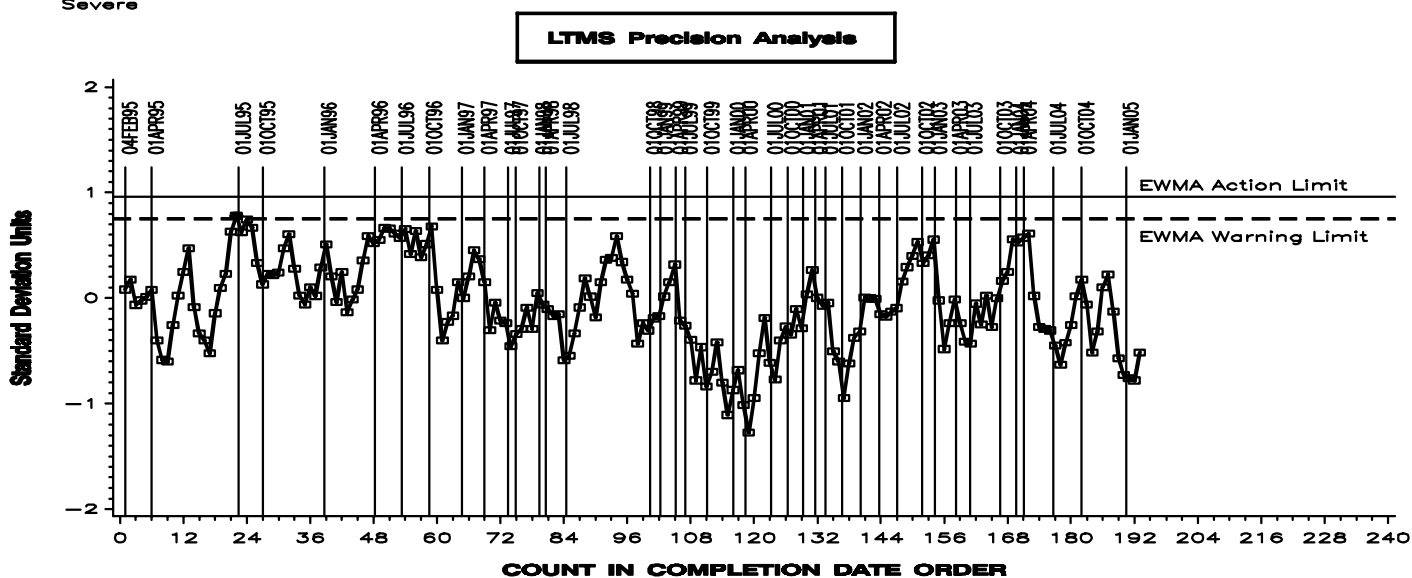
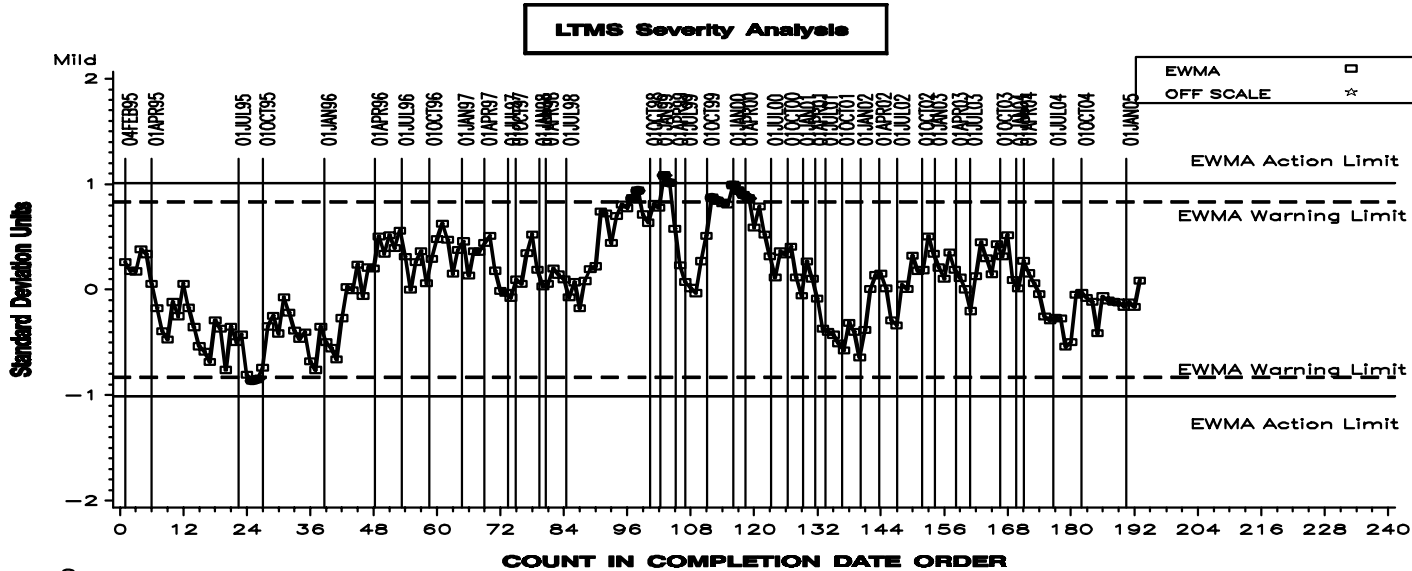


CUSUM Severity Analysis



L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

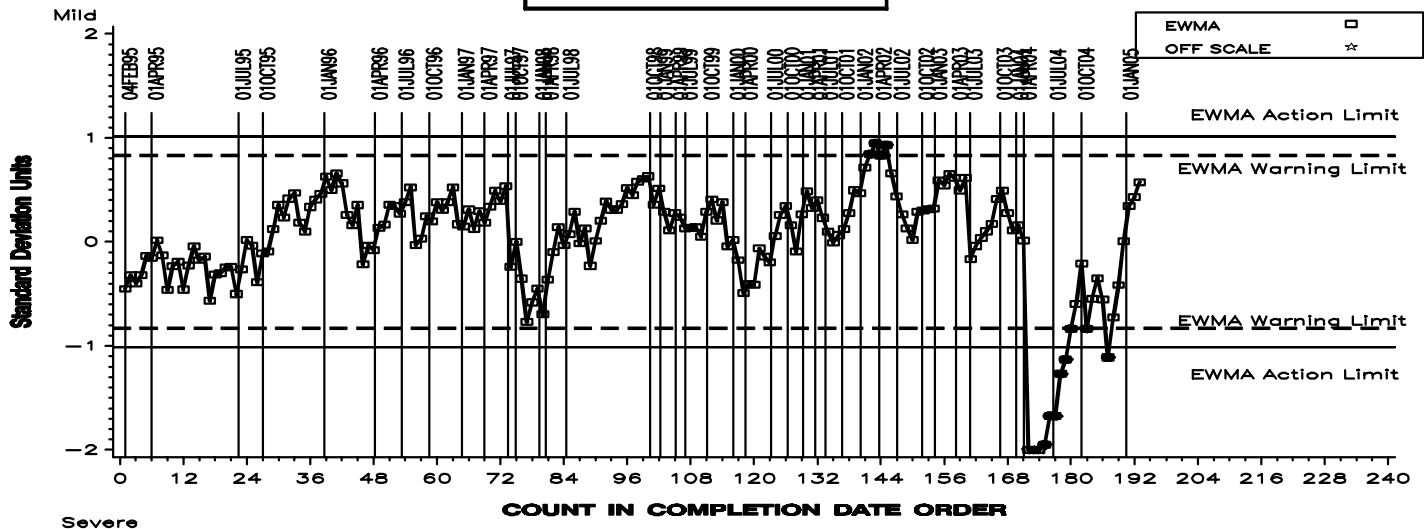
FINAL PINION GEAR RIDGING



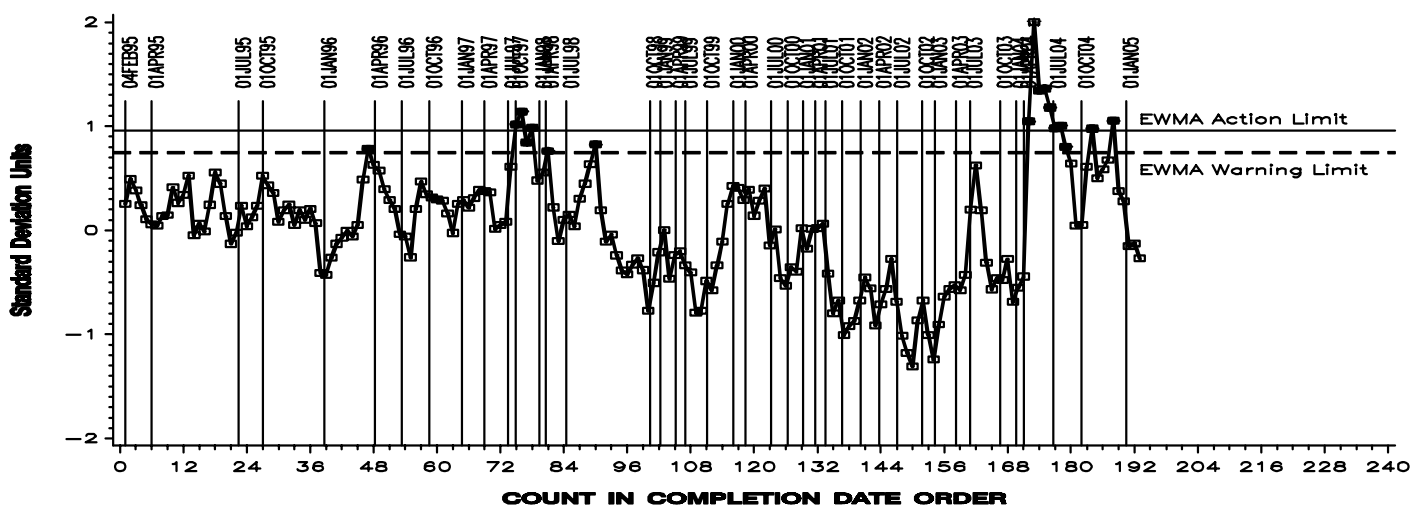
L-37 NONLUBRITED INDUSTRY OPERATIONALLY VALID DATA

FINAL PINION GEAR PITTING/SPALLING

LTMS Severity Analysis



LTMS Precision Analysis



CUSUM Severity Analysis

