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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

October 5th, 2010

Reply to:
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ASTM D02.B0.03 L-37 Surveillance Panel
Members and Guests:

Attached for your review and comment are the unconfirmed minutes of the:

- **October 5th, 2010 L-37 Surveillance Panel Meeting**

Please direct any corrections or comments to my attention.

Sincerely,

Galen Greene, Chairman
L-37 Surveillance Panel

Report of Meeting
L-37 Surveillance Panel Teleconference

September 10th, 2010

Attendees:

SwRI -	**Koehler**
Lubrizol -	**Greene**, Gropp, Venhoff, Schiferl, Wang, Martin
Afton -	**Koglin**, McAlister
Intertek-Parc -	**Smith**
TMC -	**Parke**, Lind
Chevron -	**Zakarian**
Arvin Meritor -	**McGlone**

Voting Members in **BOLD**

The meeting was called to order at 10:30 am EDT.

1.0 Summary of Meeting Discussions

1.1 L-37 Control Charting and Reference Acceptance

At the 8/12/10 Surveillance Panel meeting, a discussion was started regarding the method used for control charting the distress parameters of the L-37 test. There was some concern that the current method does not set reference acceptance bands that make logical sense. A statistical task force group was formed and met several times to explore the issue. The group's findings are attached in attachment 1.

After reviewing the task force's findings, the group discussed the proposal. Mr. Parke proposed that we use the sample standard deviation for all n sizes versus using a pooled standard deviation for n sizes 15 or greater. A quick calculation for ridging on the current batch (P4T813) showed that the sample standard deviation was about 0.6 and the pooled standard deviation was 0.5. This change had no effect on the reference acceptance bands in this case.

There was also some discussion regarding the spitting bands for the most recent batch. The updated bands from the new method were smaller than the current method. It was also noticed that the bands were wider for the P4L792 batch. It was noted that there was no change in previous acceptable reference tests when comparing current to proposed methods as there was no data in the regions where the two methods didn't overlap (for pitting/spalling only).

After some further discussion the following motion was made:

Motion # 1 → Mr. Greene - Motion to adopt the following method for control charting and reference acceptance in the L-37 test area:

1. Keep current non-transformed method for Wear
2. Discontinue current transformation method for Ridging, Rippling and Pitting/Spalling.
3. Use non-transformed bands for Wear, Ridging, Rippling and Pitting/Spalling (mean ± k•s) (note: no change for wear)
4. Apply ASTM rounding to calculated bands for Wear, Ridging, Rippling and Pitting/Spalling
    - Round the end points of the bands for Wear, Ridging, Rippling and Pitting/Spalling to integers
    - Round the end points of the bands for Pitting/Spalling to tenths between 9 and 10 and round to integers when less than 9
5. Use sample standard deviation for all n sizes
6. Effective date will be November 1st, 2010

2nd – Zakarian. The motion passed with a vote of – Yes-7, No-0, Abstensions-0

It was then discussed that the temporary waiver on the upper limit of Ridging is set to expire before the November 1st date. The following motion was proposed to extend the waiver:

Motion # 2 → Mr. Lind - Motion to extend the waiver on consequences of positive shewhart alarms (top of band) on ridging only for both pass oils to November 1st, 2010 (P4T813 batch). 2nd – Greene. The motion passed with a vote of – Yes-7, No-0, Abstensions-0

2.0 Adjournment

The meeting was adjourned at 11:35 am EDT

Respectfully submitted,

Galen Greene
L-37 Surveillance Panel Chairman

Attachement 1

Control Charts for L-37

Zhen Wang

Statistical Sciences

Oct, 5th, 2010

Recall Goals of Charting

- Minimize risk of false alarms (calling something out of control when it isn’t)
- Minimize risk of missing signal that process is out of control
- They are not independent – doing one affects the other

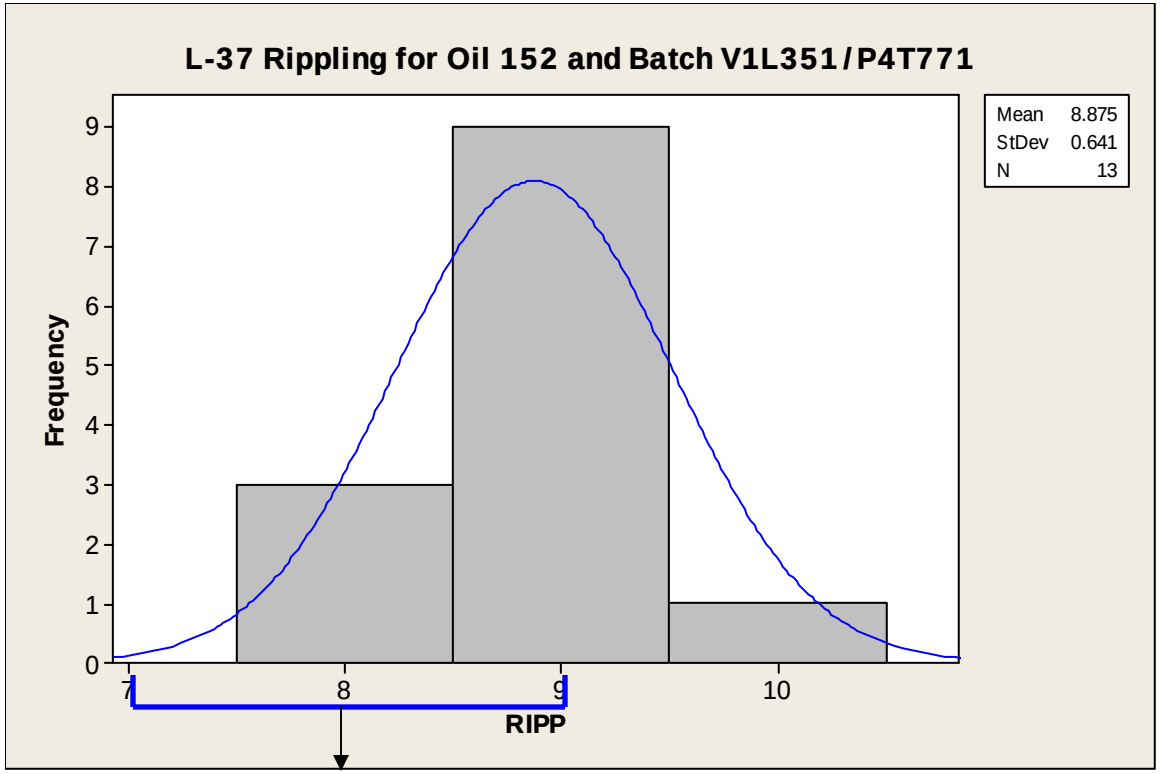
Attachement 1

Old Method for L-37 Shewhart Control Chart

- Transformation: Ti = -log(10.5-Ri)
- Assume that Ti follows a normal distribution
- Some issues with limits
  - Can get a single number if we do not modify the standard deviation to expand Shewhart band
  - We can get bands which do not make sense
  - Chance of labeling something out of control which truly is not is > or < than expected

Example from 2004 to 2006 (13 runs with batch V1L351/P4T771)

Bands include 7 but not 10, even though 10 rating was observed in the first 8 runs.



current bands from first 8 runs are 7 to 9

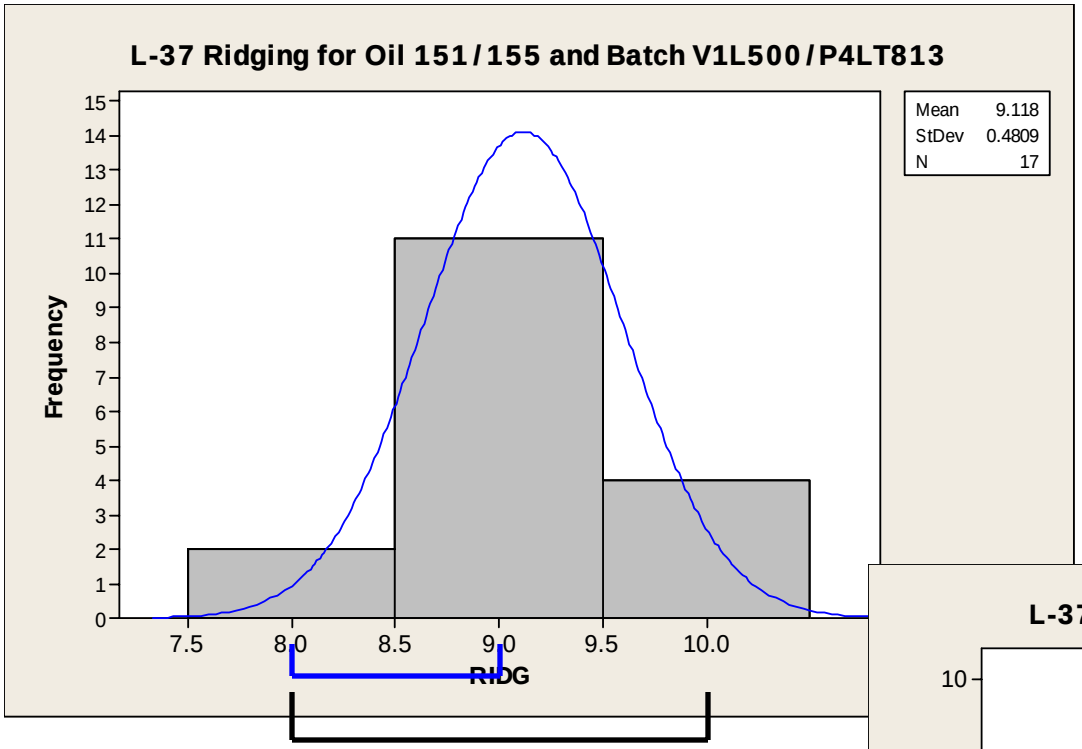
Approaches

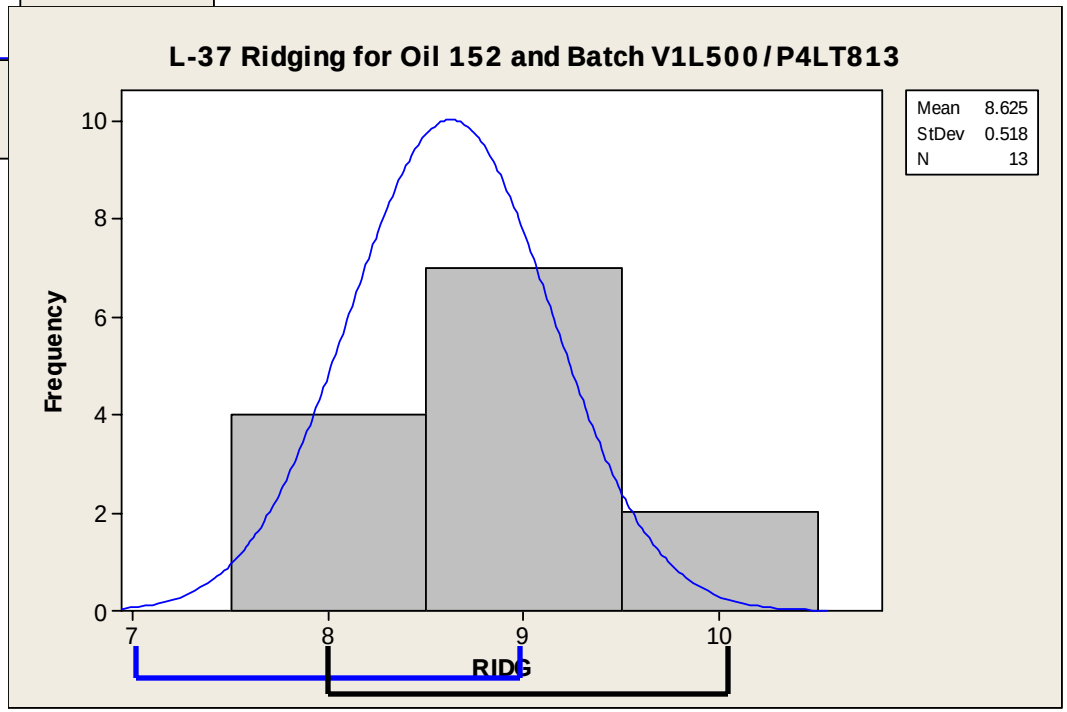
1. Looked at probabilities of getting each of the ratings
   - hard to use for small data set unless a prior distribution is assumed, statistics are complicated.
2. Looked at transformations which can improve normality of the data
   - Did not focus on search of transformations
   - Did not find any transformations which work better than the current one
3. Assume the original rating Ri follows a normal distribution (do not transform the ratings)
   - This would be consistent with ratings existing between intervals but only end points reported
   - Calculate the target mean by averaging ratings
   - Use sample standard deviation when n=8 and use pooled standard deviation across labs when n >=15
   - The interval is mean $\pm$ k•s and round end points of the interval.
   - For example, for oil 151-2 and batch V1L686/P4L626A, the ridging data used in the target calculation is in the following table. The average ridging rating is 9.250 and the sample standard deviation is 0.463. The interval is (9.25-1.8*0.463, 9.25+1.8*0.463) = (8.4166,10.0834). Then the interval (8.4166,10.0834) is rounded to (8, 10).

TESTKEY	LTMSLAB	LTMSAPP	STRUN	IND	RINGBAT	VAL	CHART	TESTHARI	LTMSDATI	COM1	LTMSTIME	RIDG	
33944	D	3	507	151-2	P4L626A	AG	N	NONLUBR	20000318	TARGETS	9:44	10	
33945	D	3	508	151-2	P4L626A	AG	N	NONLUBR	20000320	TARGETS	10:44	10	
33948	B	1	1373	151-2	P4L626A	AG	N	NONLUBR	20000321	TARGETS	18:07	9	
33949	B	1	1374	151-2	P4L626A	AG	N	NONLUBR	20000323	TARGETS	4:05	9	
33940	E	1	560	151-2	P4L626A	AG	N	NONLUBR	20000323	TARGETS	12:10	9	
33941	E	1	561	151-2	P4L626A	AG	N	NONLUBR	20000324	TARGETS	14:39	9	
36042	A	2	2264	151-2	P4L626A	AG	N	NONLUBR	20000331	TARGETS	15:00	9	
36043	A	2	2266	151-2	P4L626A	AG	N	NONLUBR	20000406	TARGETS	11:30	9	

Attachement 1

Example: Ridging Reference Data for Batch V1L500/P4LT813



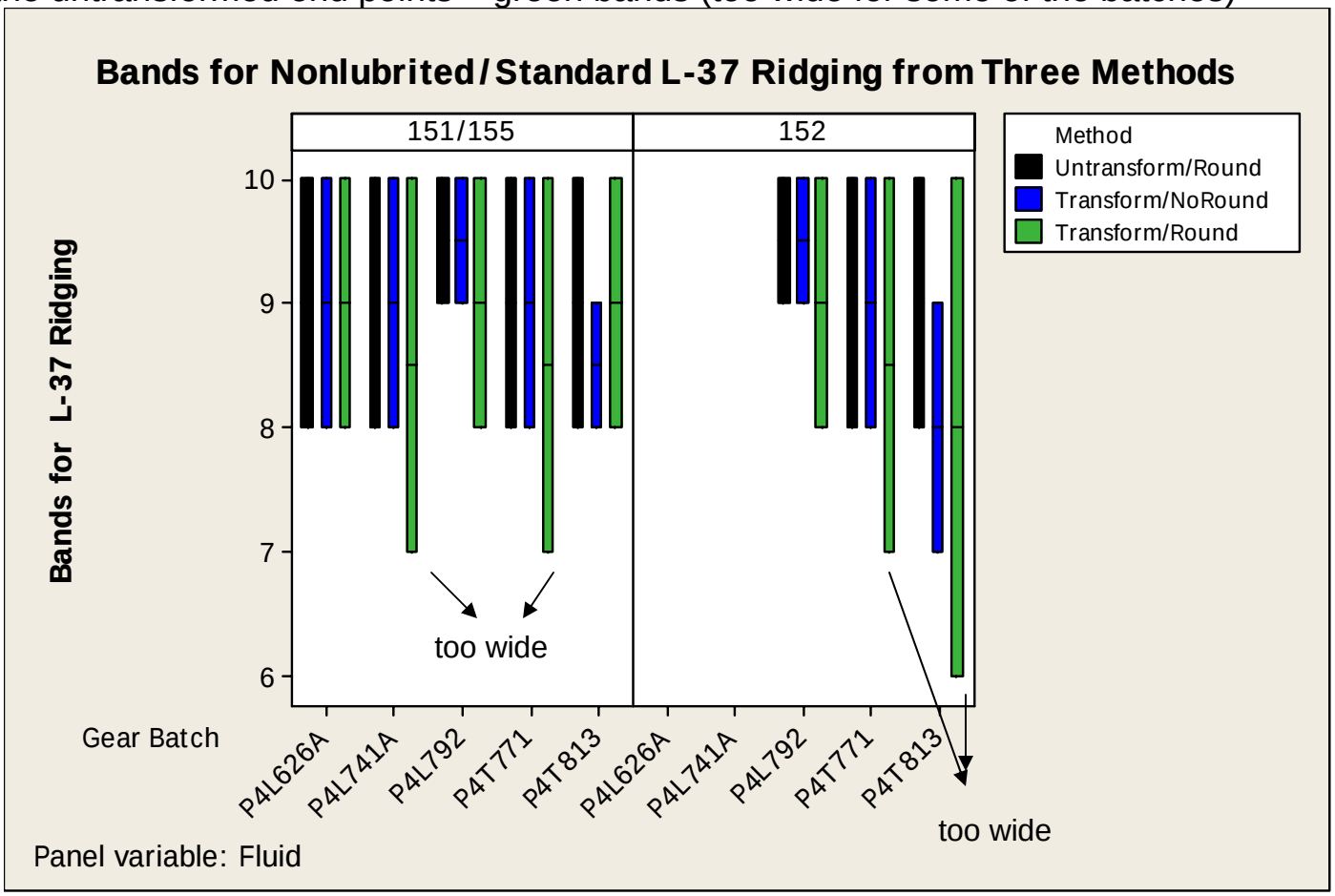


Note that all batches but one had 10 in the bands. Blue bands are from old method and black bands are from new method.

Attachement 1

Bands for Nonlubrited/Standard L-37 Ridging from Three methods

1. Do not transform the data, round the end points of the interval – black bands (proposed method)
2. Transform the data, do not round the end points of the interval – blue bands (current LTMS method)
3. Transform the data first and calculate the interval, transform back the end points, then round the untransformed end points – green bands (too wide for some of the batches)

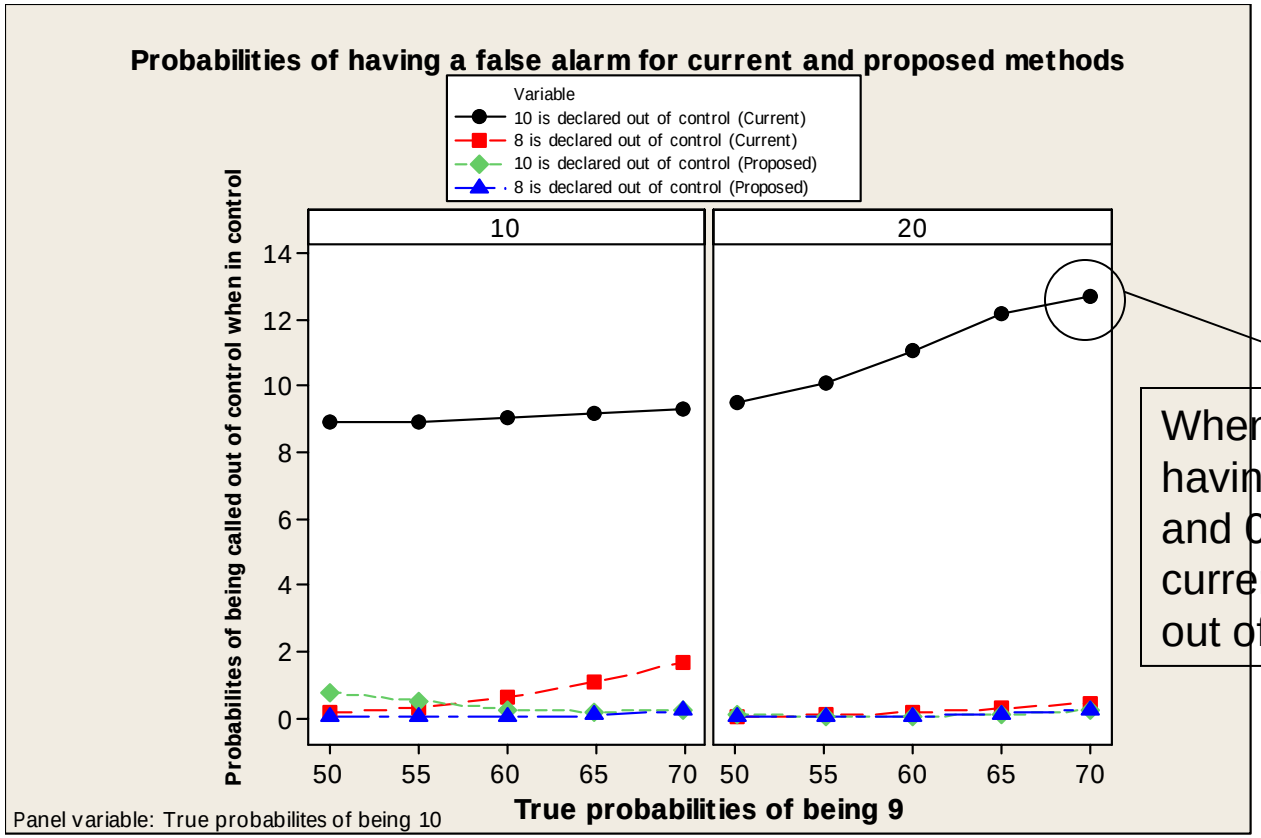


The proposed method (untransform/Round) does not change intervals except last batch.

Attachement 1

Simulation – Ratings at 8, 9 and 10 for one fluid/batch

- Simulated test results when the true distribution is known (specify the probabilities of having 8, 9 and 10)
- Calculated the bands from the current method and proposed method
- Calculated the probabilities that the bands do not include 8 or 10
  - Probabilities of declaring out of control test runs which are truly not (shown on the plot).
- The current transformation makes a propensity that 10 would not be included.

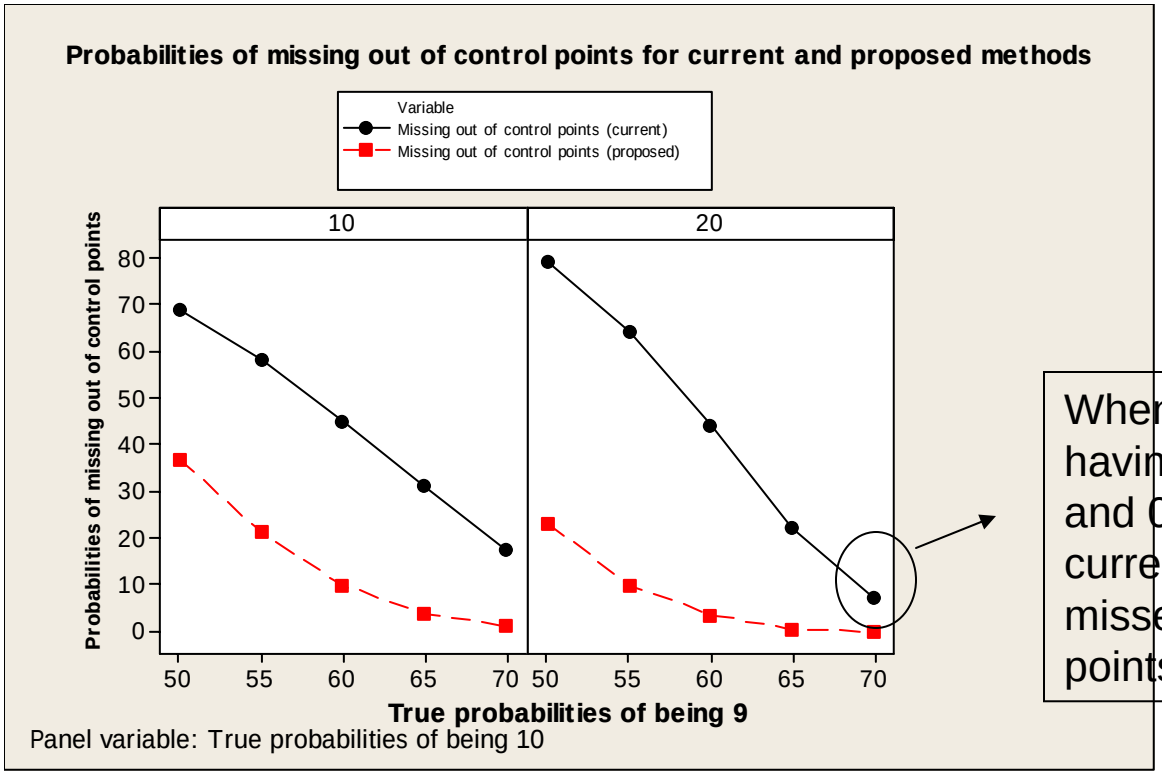


When the true probabilities of having 8, 9 and 10 are 0.1, 0.7 and 0.2, 12% of the time the current method would declare 10 out of control.

Attachement 1

Simulation – Ratings at 8, 9 and 10 for one fluid/batch

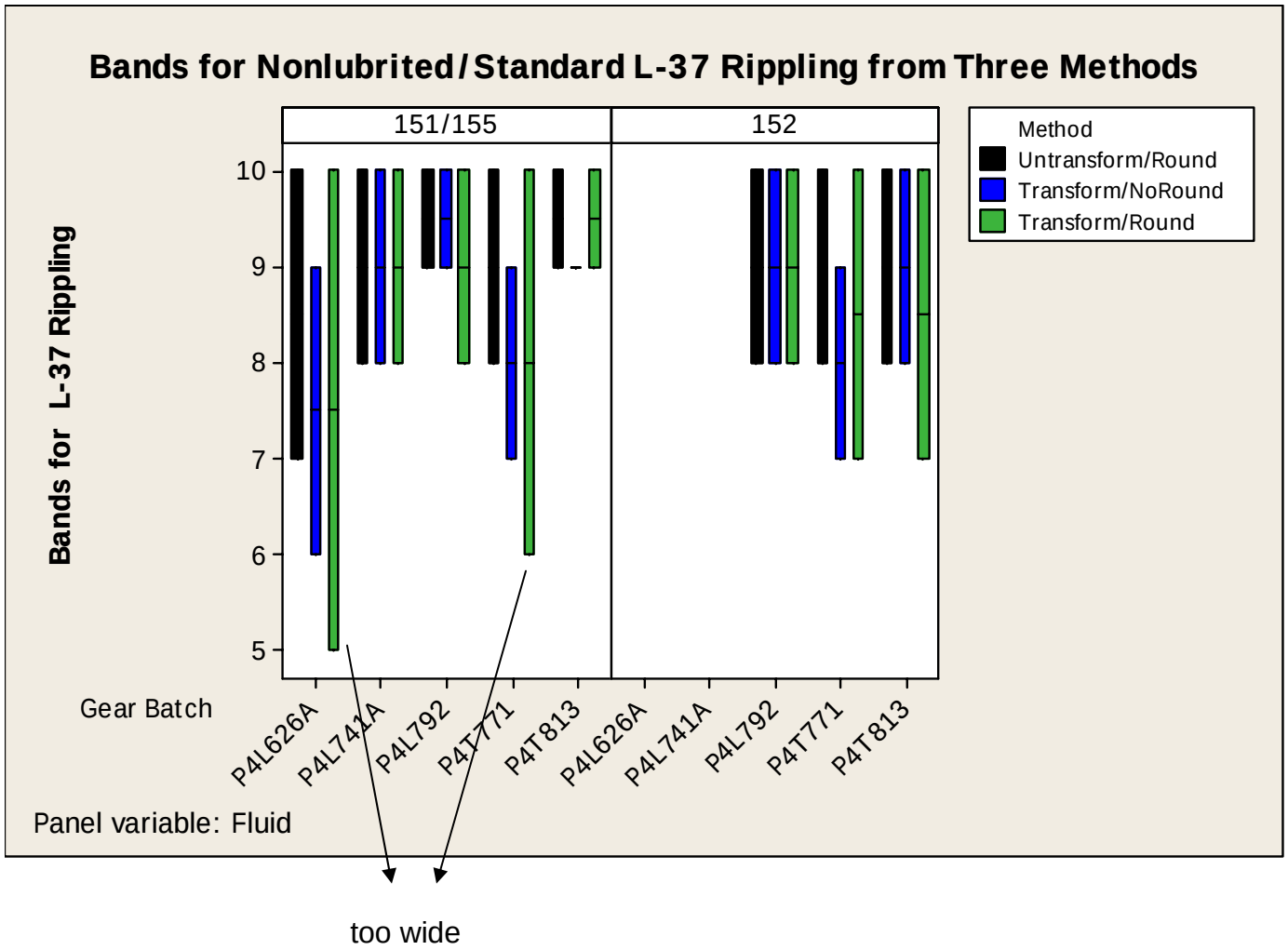
- Simulated test results when the true distribution is known (specify the probabilities of having 8, 9 and 10)
- Calculated the bands from the current method and proposed method
- Calculated the probabilities that the bands include ratings less than 8 (shown on the plot)
  - Probabilities of missing out of control points
- The proposed method has lower probabilities of missing truly out of control points



When the true probabilities of having 8, 9 and 10 are 0.1, 0.7 and 0.2, 10% of the time the current method would have missed truly out of control points.

Bands for Nonlubrited/Standard L-37 Rippling from Three methods

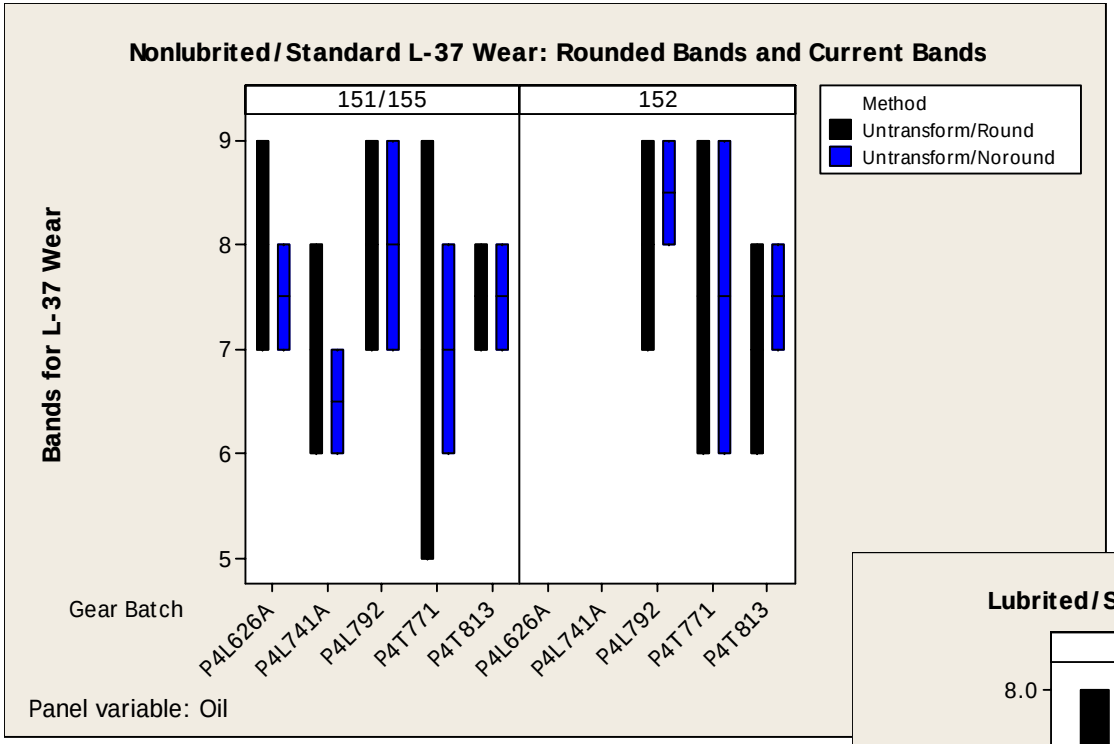
- Again, the bands from transform/round method are too wide for some of the batches.
- For rippling, the bands from the proposed method do change, but would not throw out any valid reference runs and would have allowed others (10).

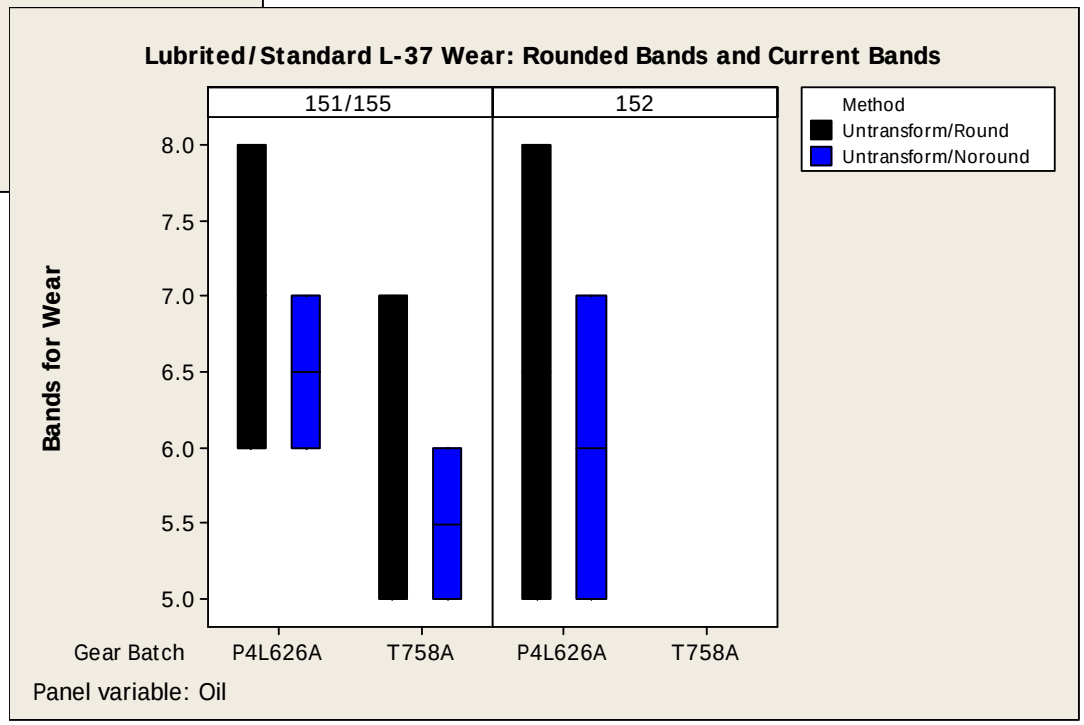


Attachement 1

Bands for L-37 Pinion Wear

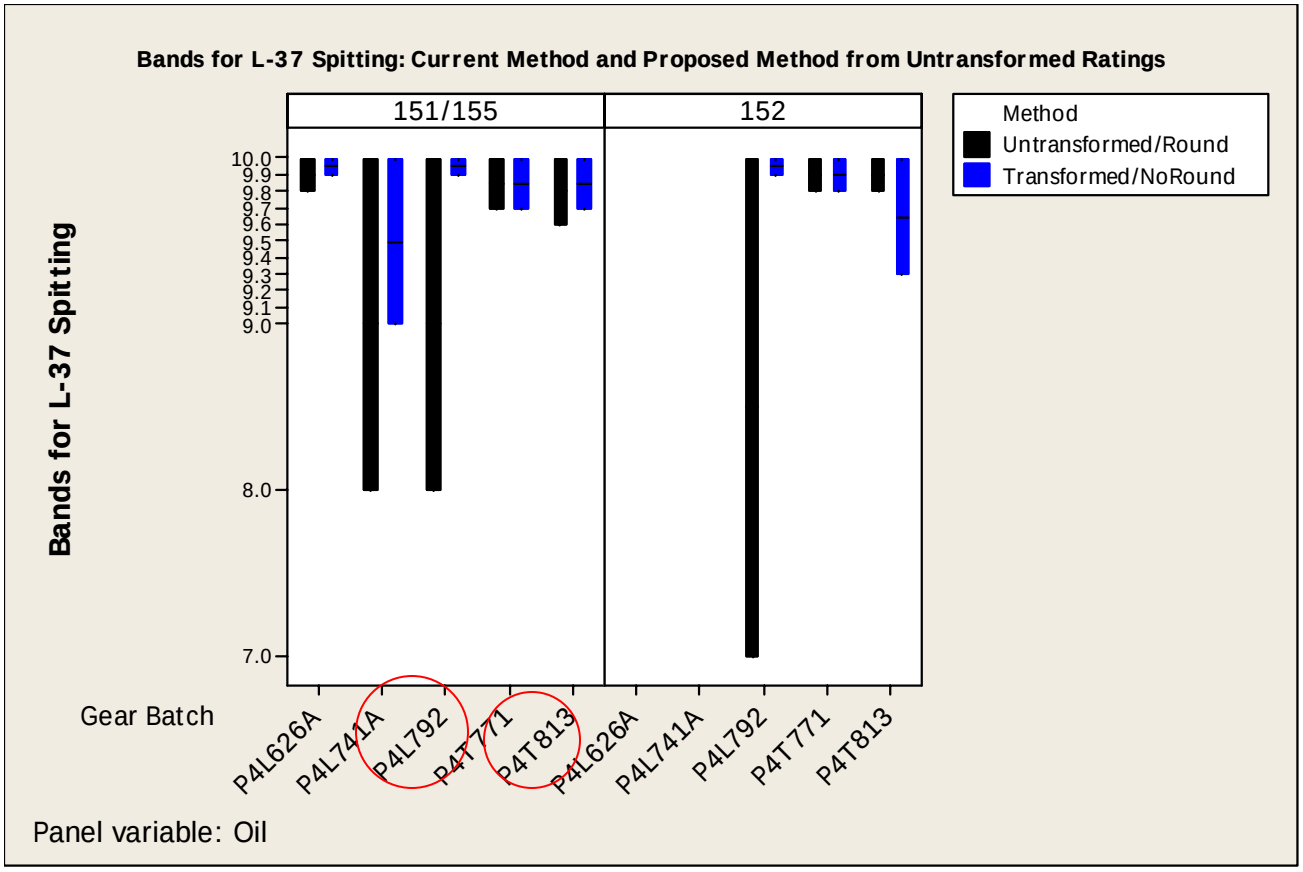
- The current bands are calculated from untransformed data
- Bands from proposed method are wider than the current bands





Nonlubrited/Standard L-37 Spitting Bands

- Bands from the proposed method are wider than the current bands
- For oil 151/155, the proposed method would have allowed one 9.8 for batch V1L417/P4L792 and one 9.6 for batch V1L500/P4T813. Other conclusions regarding declaring out of control reference runs remain the same.



Conclusions

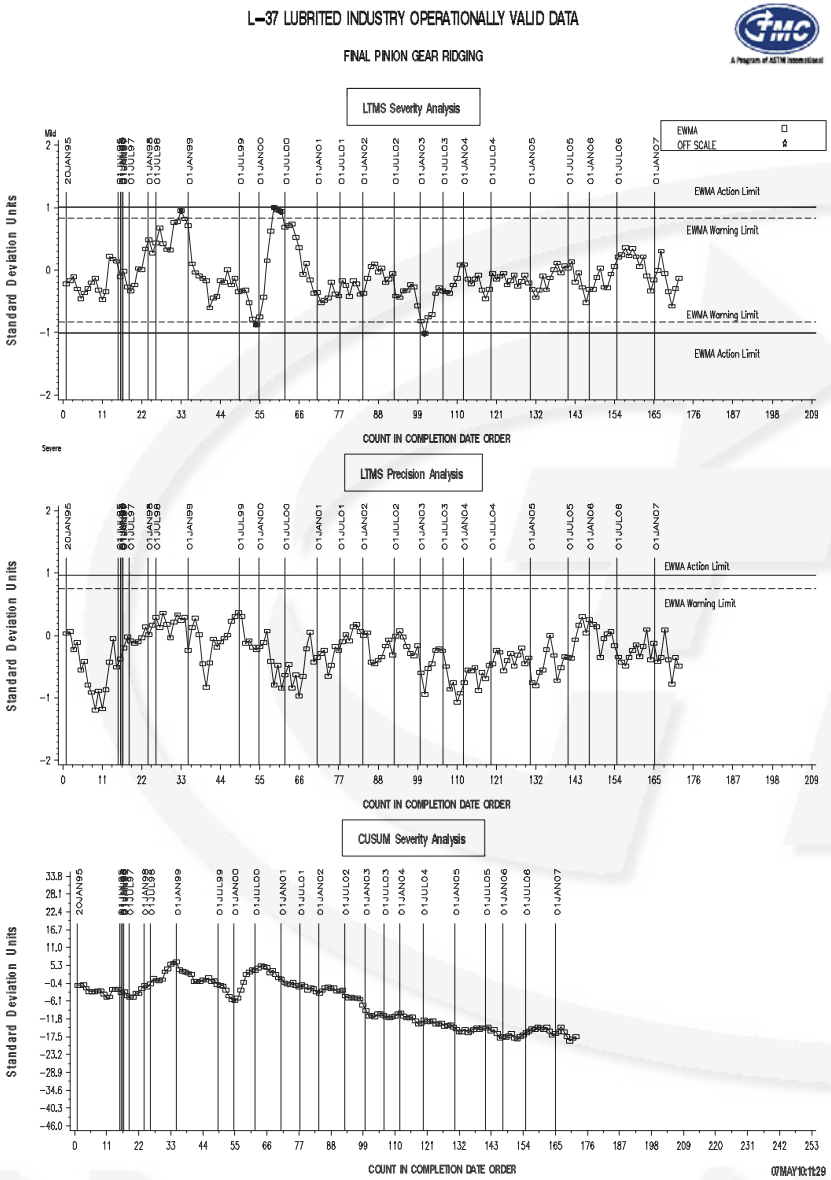
- Current method can give non-sensible results.
  - Data used to make limits may not be within limits
  - Need to adjust by hand to avoid single point limits
  - Chances of making mistakes (false alarms) are not as expected
- New method is simple and avoid problems with current method.
  - Would not change previous conclusions regarding declaring points out of control, would have allowed more 10 ratings to be in control (usually for rippling, 11 of them).
- The transform/rounding method can give too wide intervals so we will miss some truly out of control results
- For wear, current method (which does not use a transformation) can give narrower intervals than the rounding method
  - Current method is using untransformed data
  - Rounding the end points of the bands will open the interval up for some of the batches and likely cause us to miss some truly out of control points

Proposal

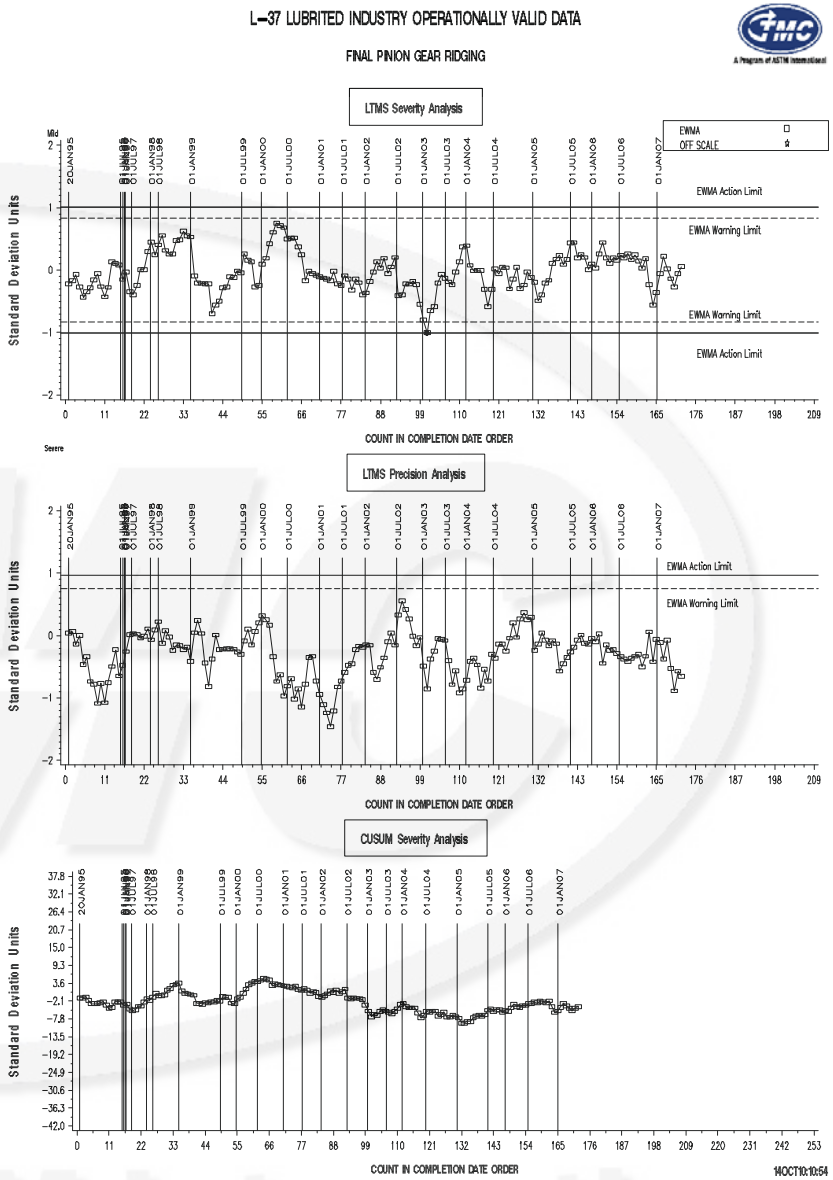
1. Keep current non-transformed method for Wear
2. Discontinue current transformation method for Ridging, Rippling and Pitting/Spalling.
3. Use non-transformed bands for Wear, Ridging, Rippling and Pitting/Spalling (mean ± k•s) (note: no change for wear)
4. Apply ASTM rounding to calculated bands for Wear, Ridging, Rippling and Pitting/Spalling
   - Round the end points of the bands for Wear, Ridging, Rippling and Pitting/Spalling to integers
   - Round the end points of the bands for Pitting/Spalling to tenths between 9 and 10 and round to integers when less than 9

Transformed vs Untransformed L37

Transformed



Untransformed



Transformed vs Untransformed L37

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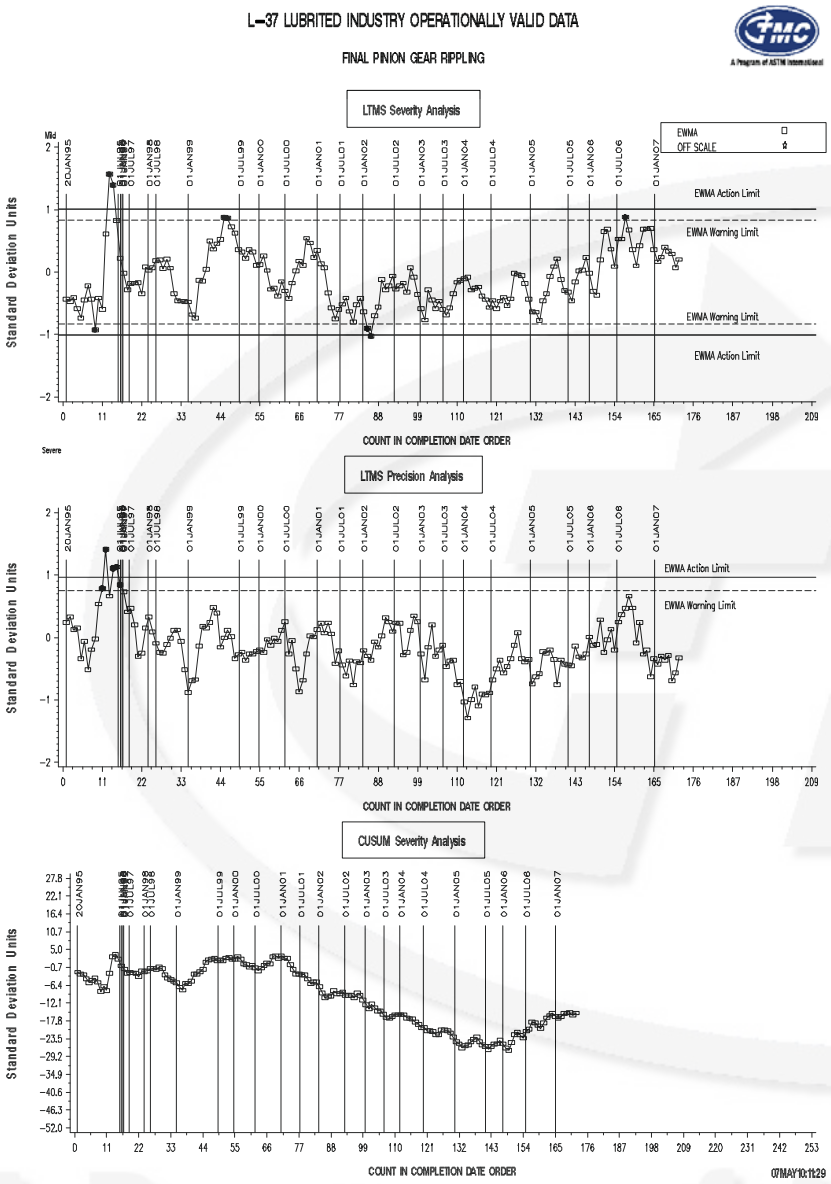
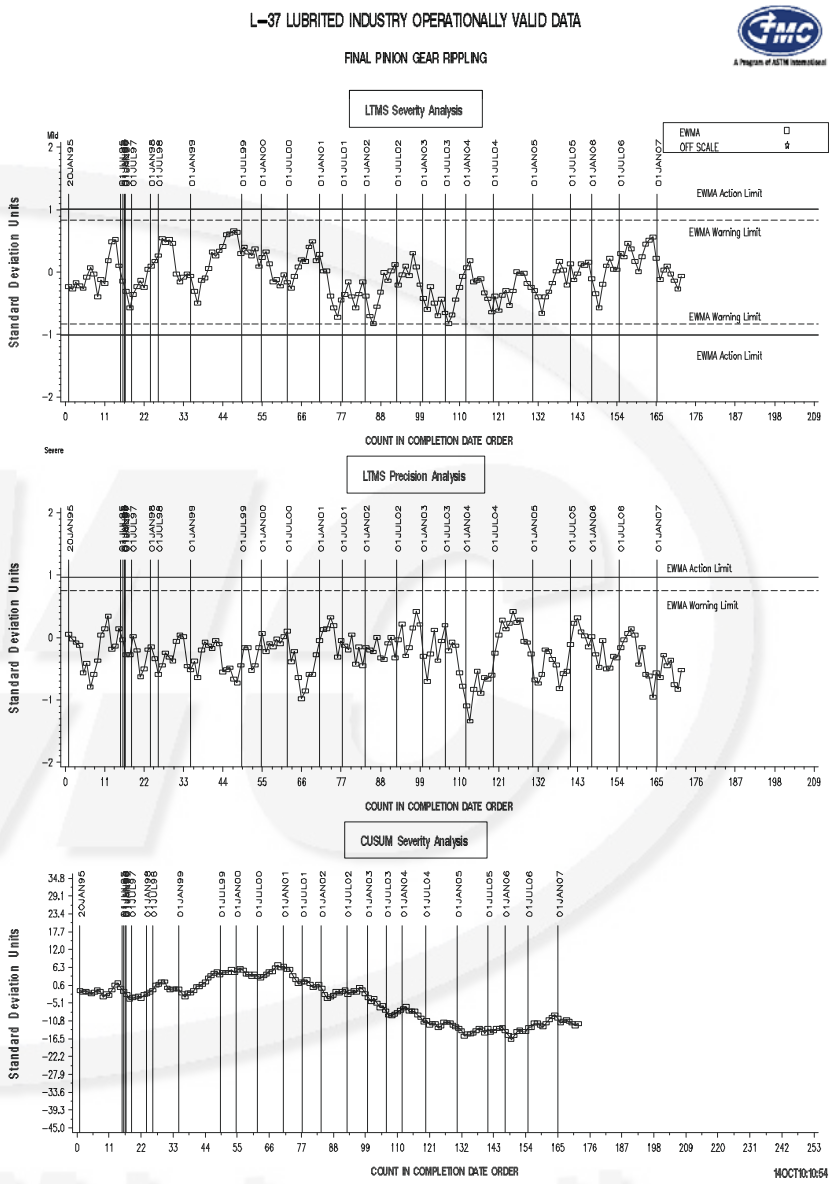


Untransformed



Transformed vs Untransformed L37

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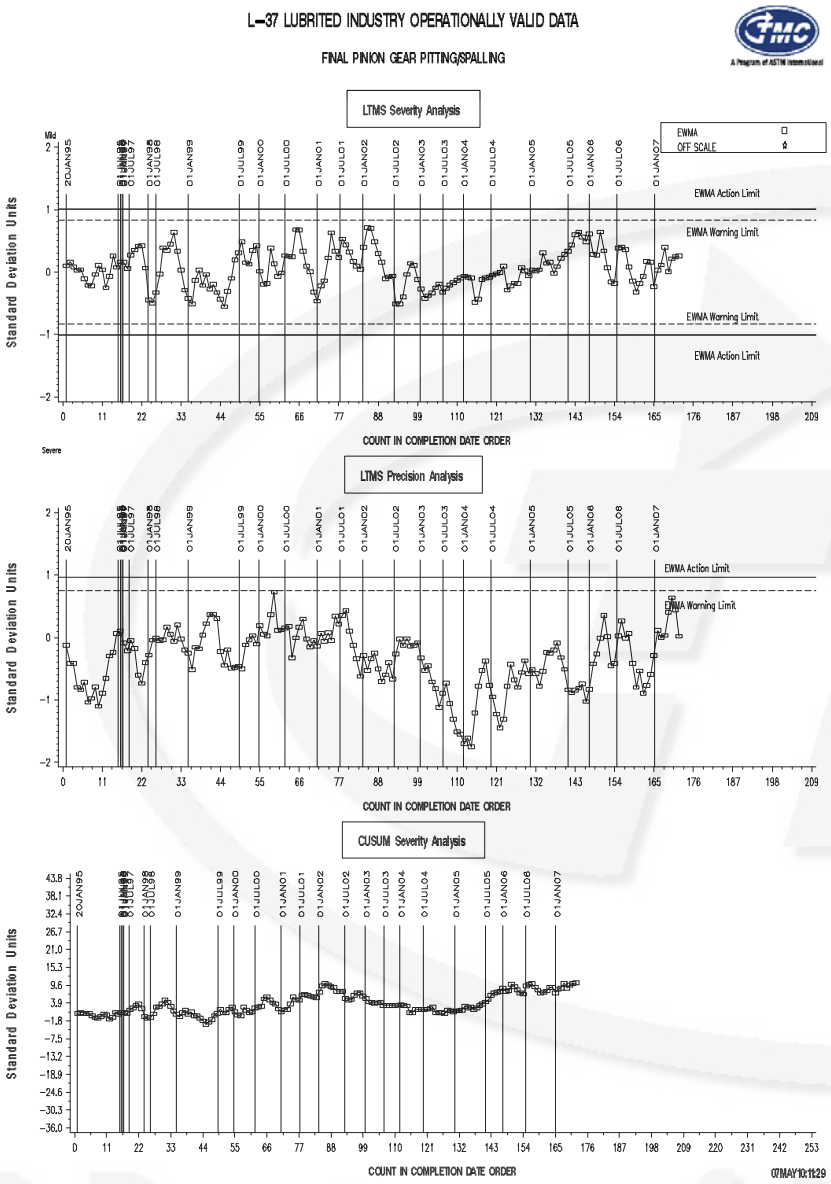

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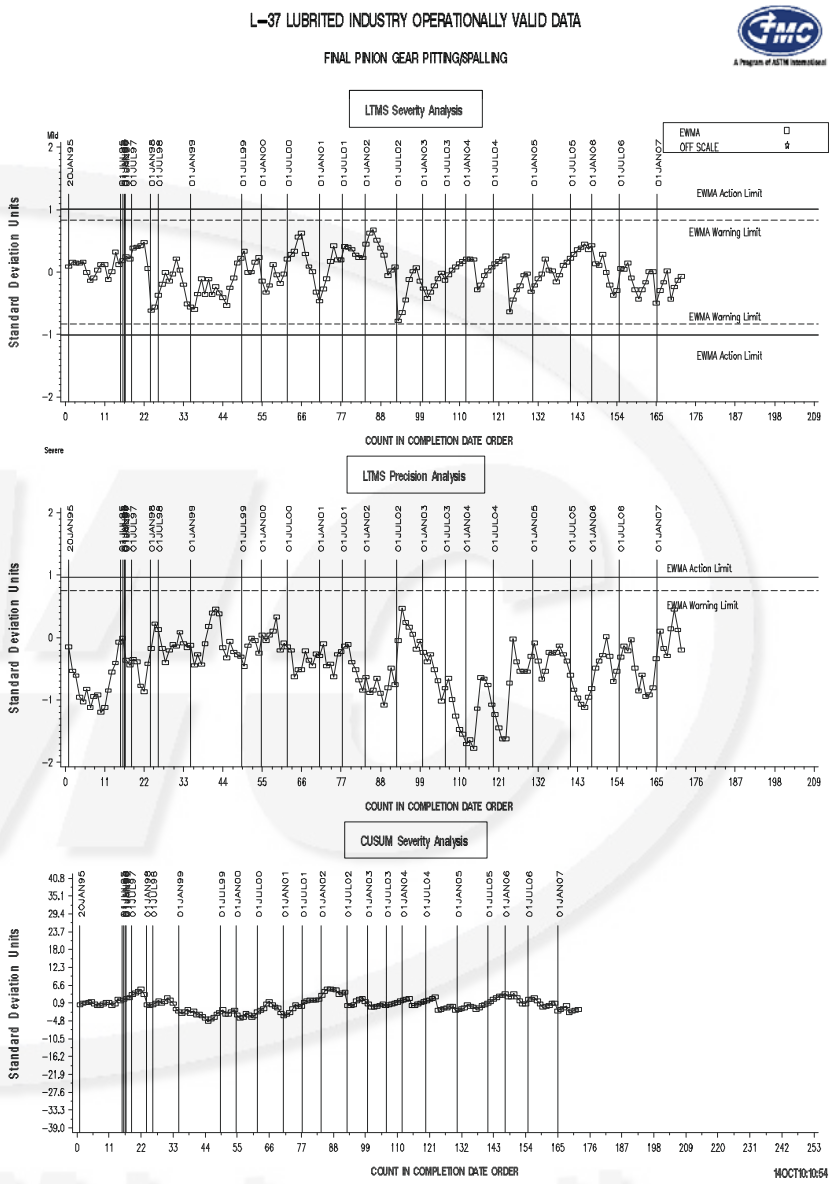
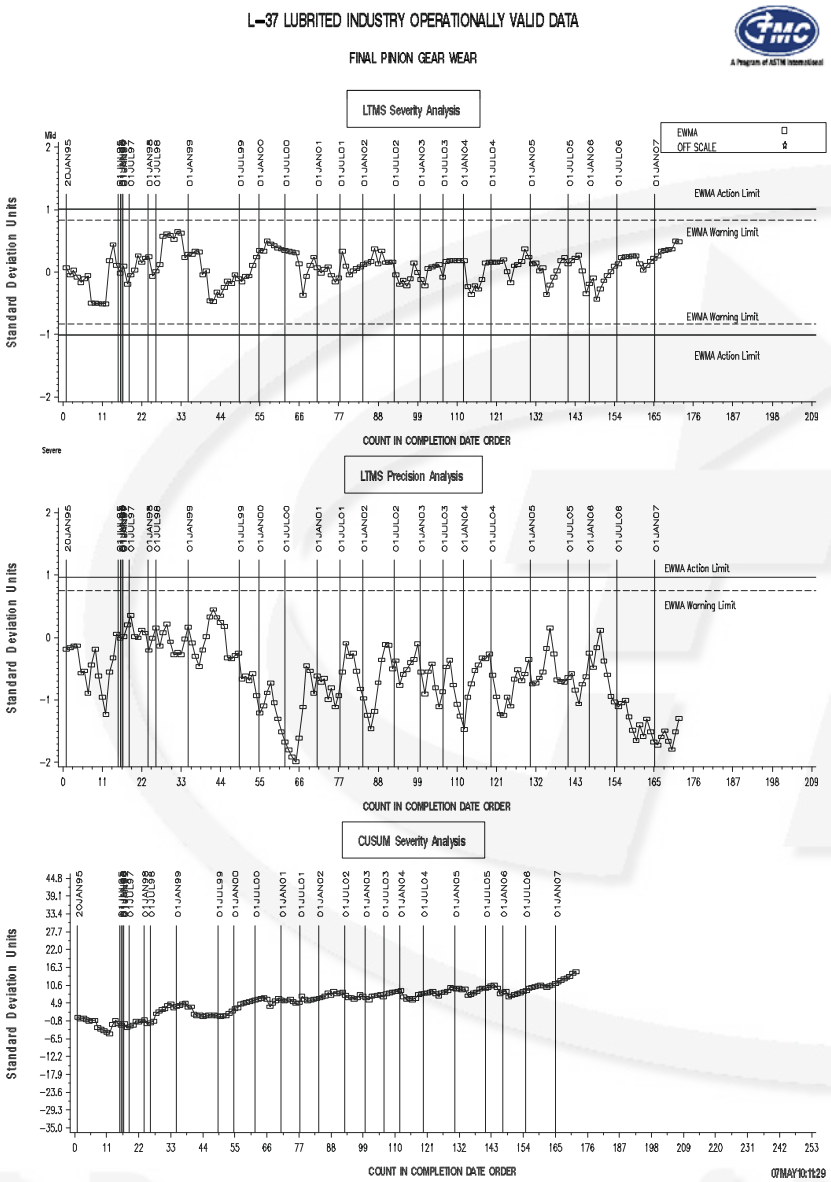
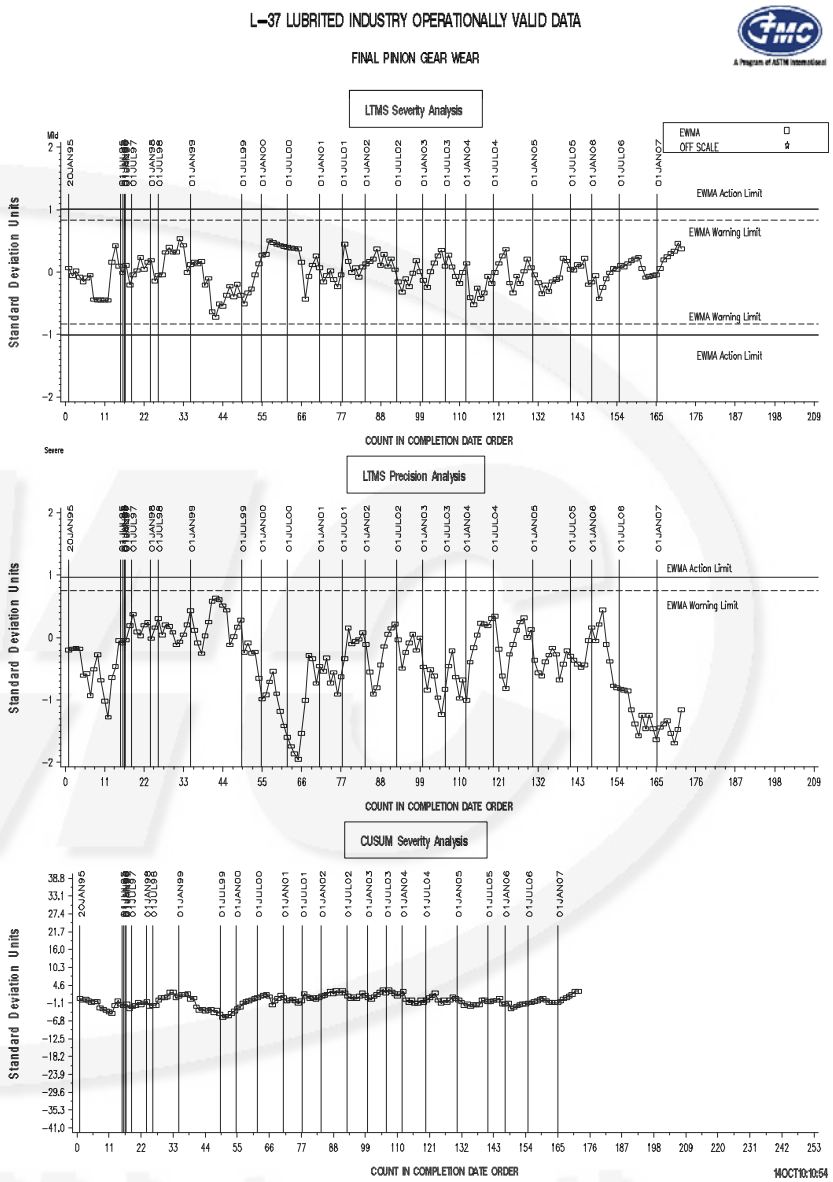


Transformed vs Untransformed L37

Transformed

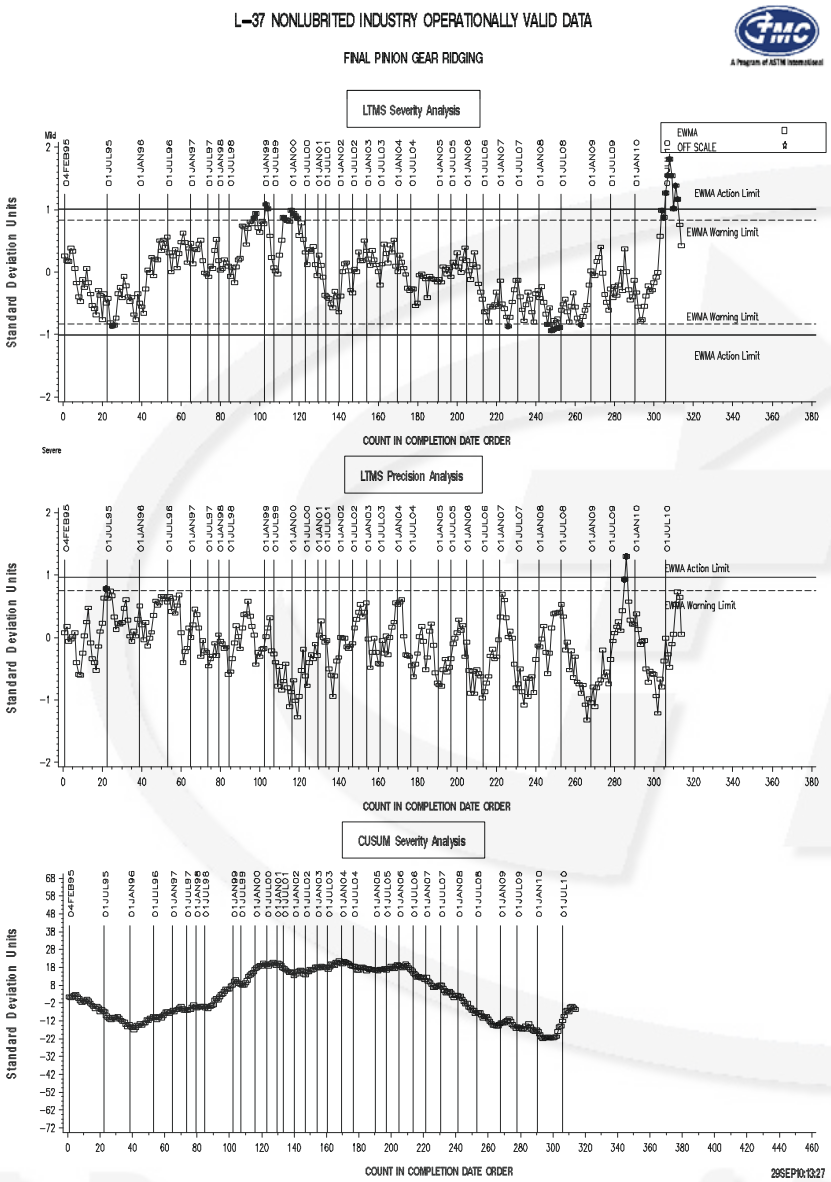


Untransformed



Transformed vs Untransformed L37

Transformed



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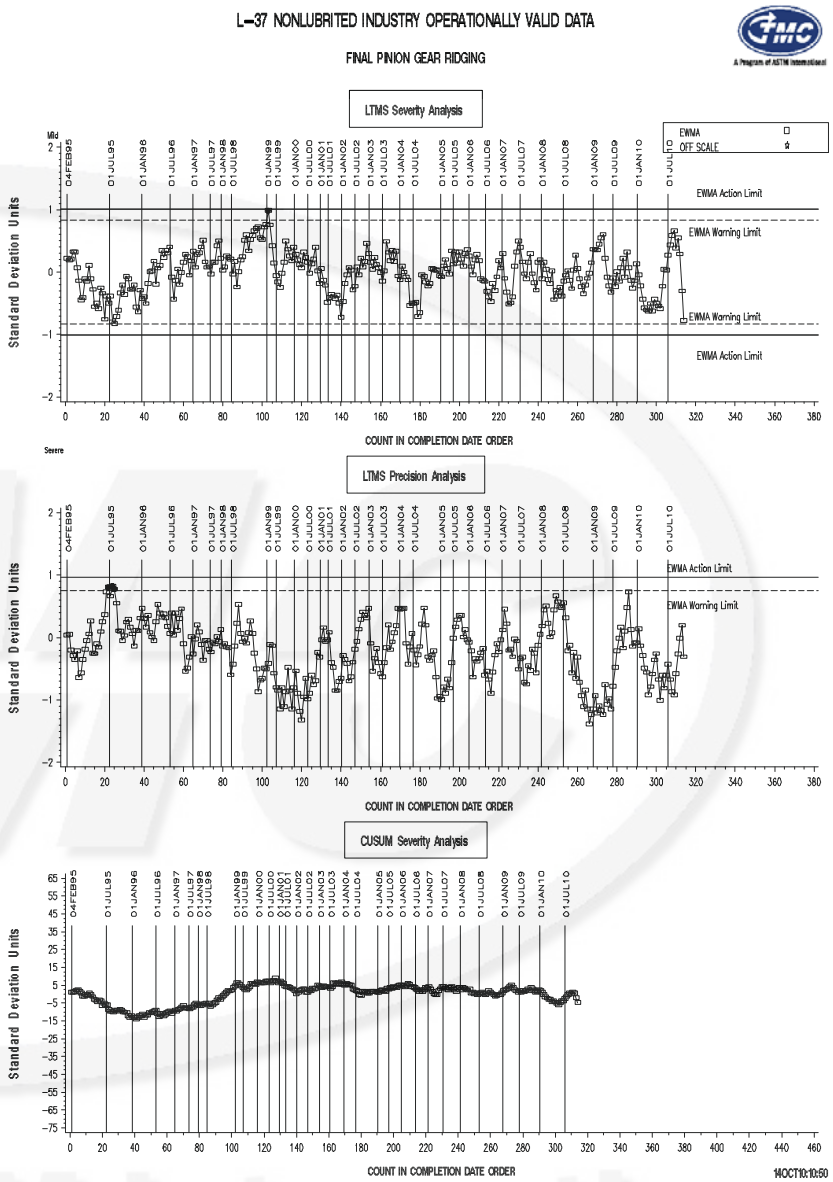

Transformed vs Untransformed L37

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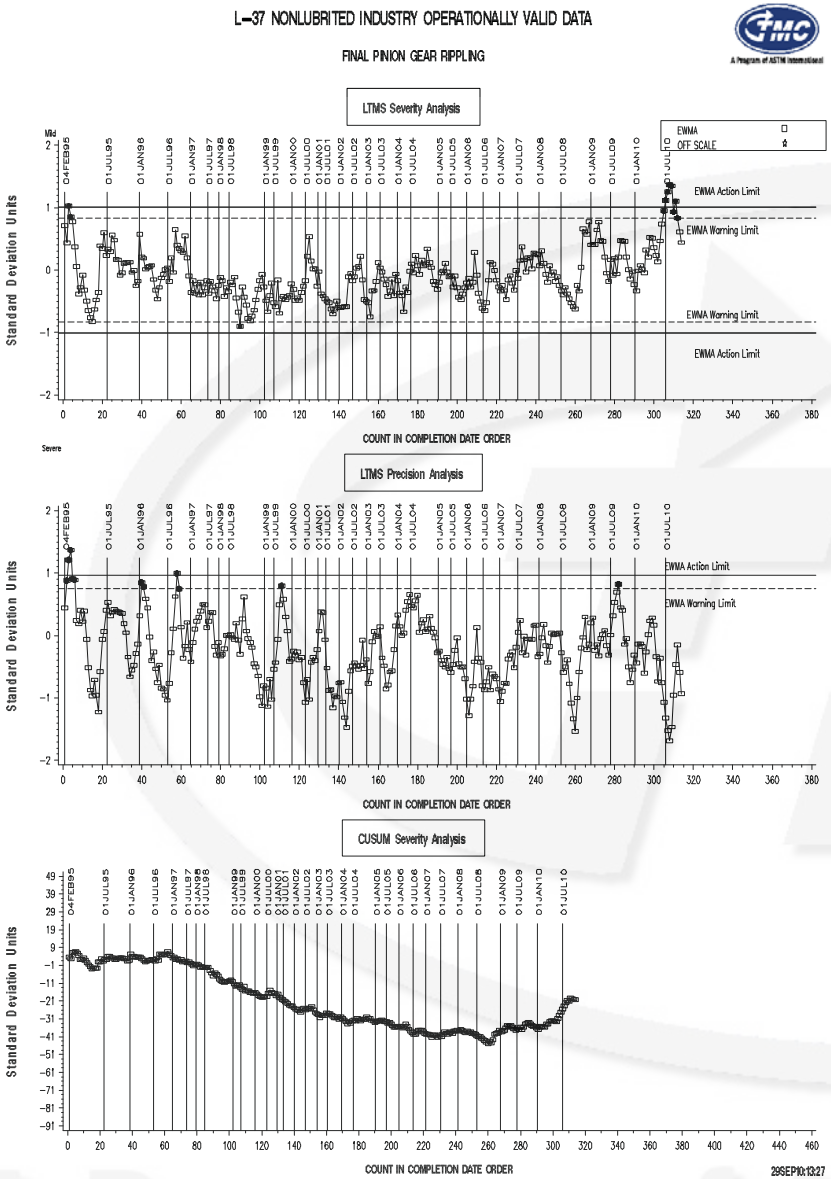

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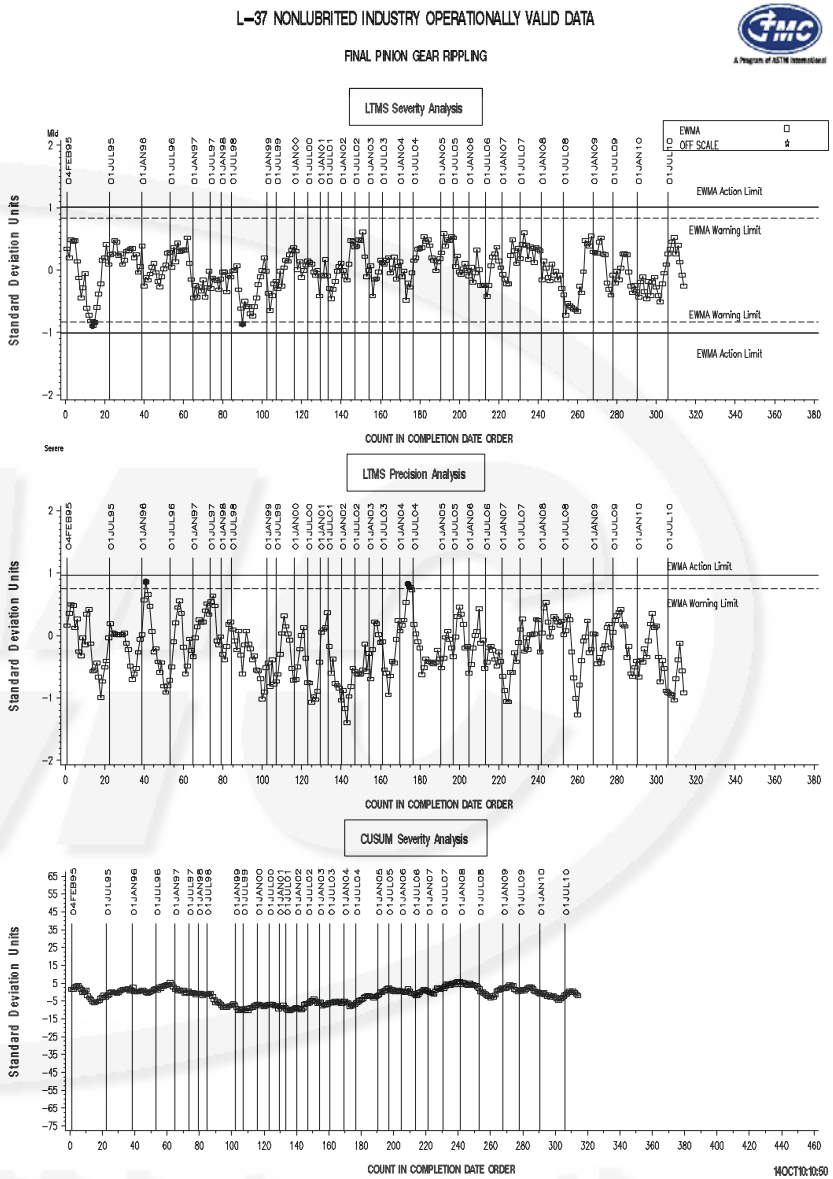

Transformed vs Untransformed L37

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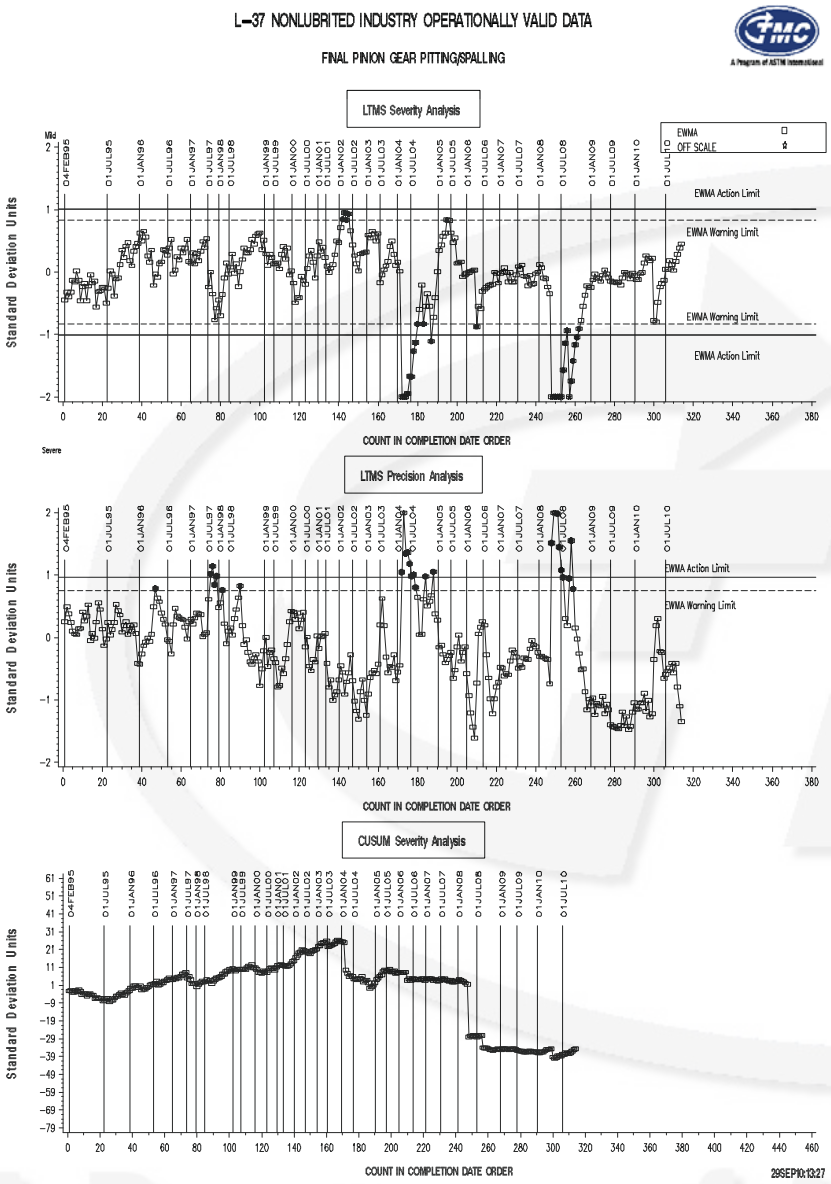

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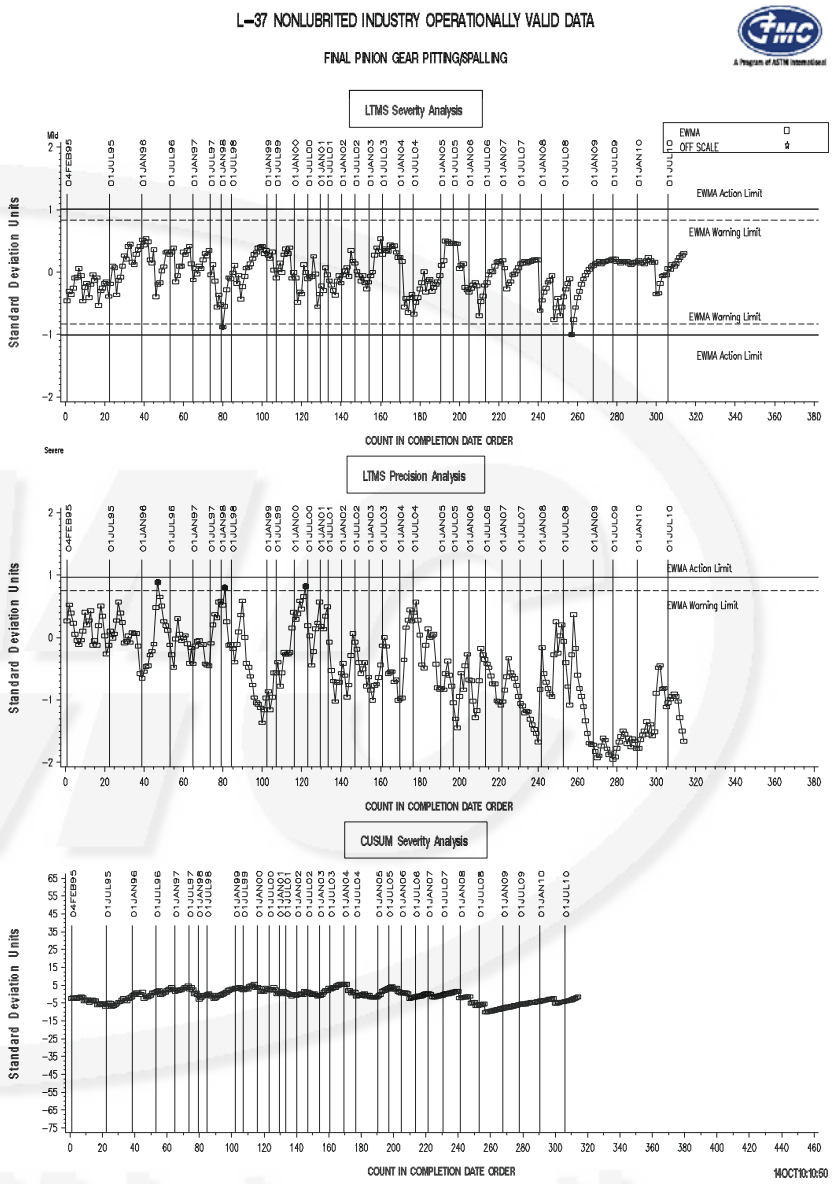
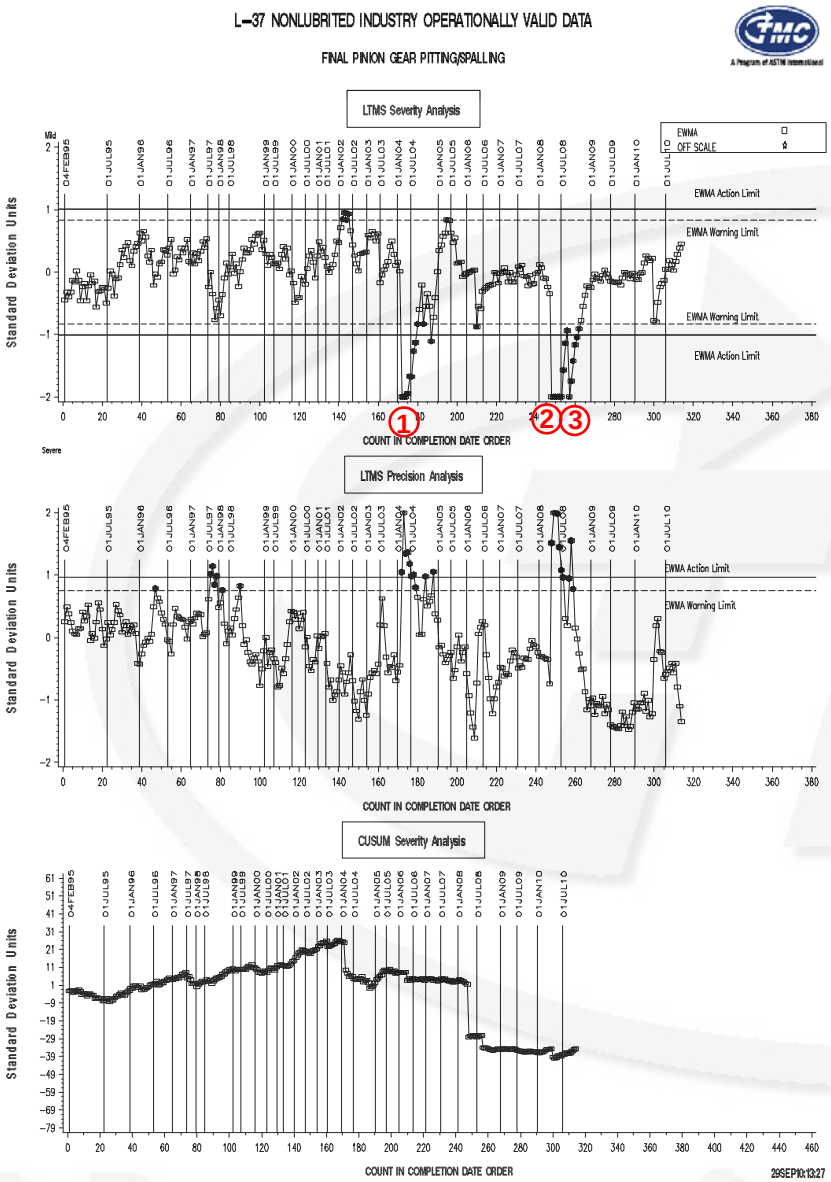
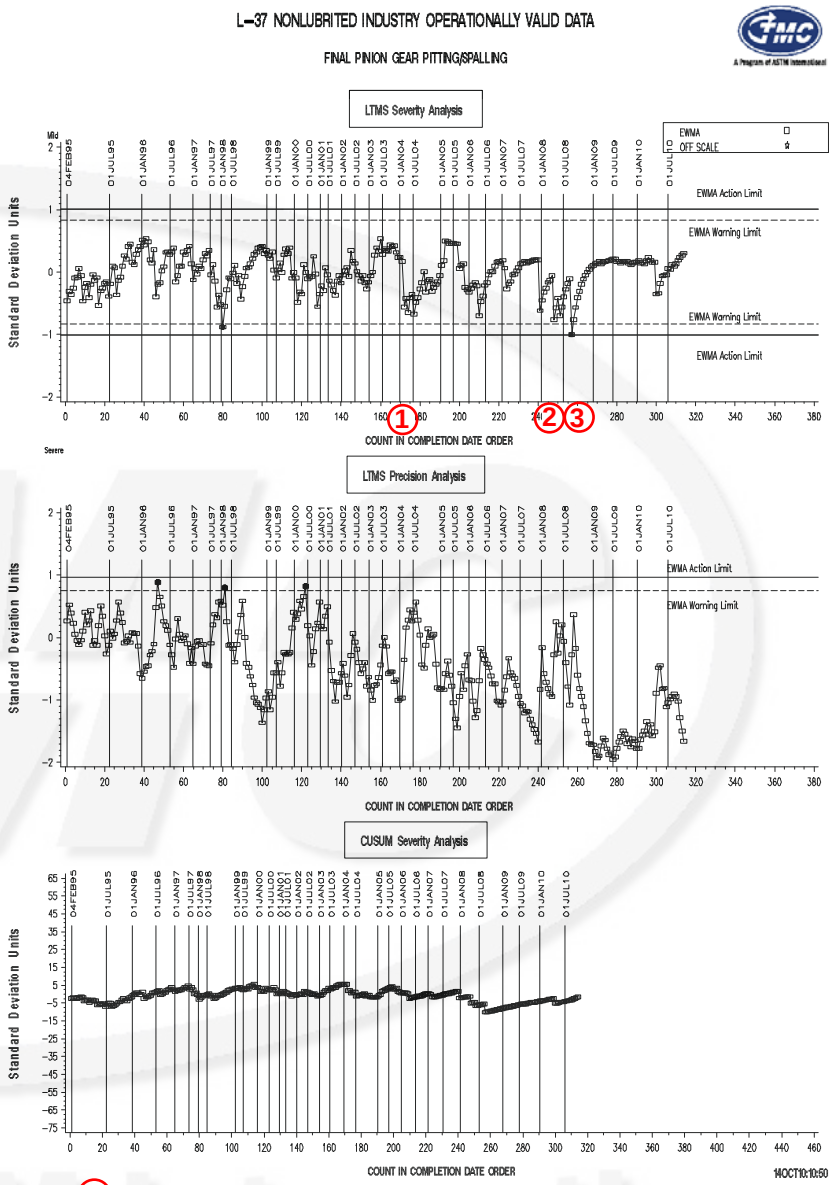


Transformed vs Untransformed L37

Transformed



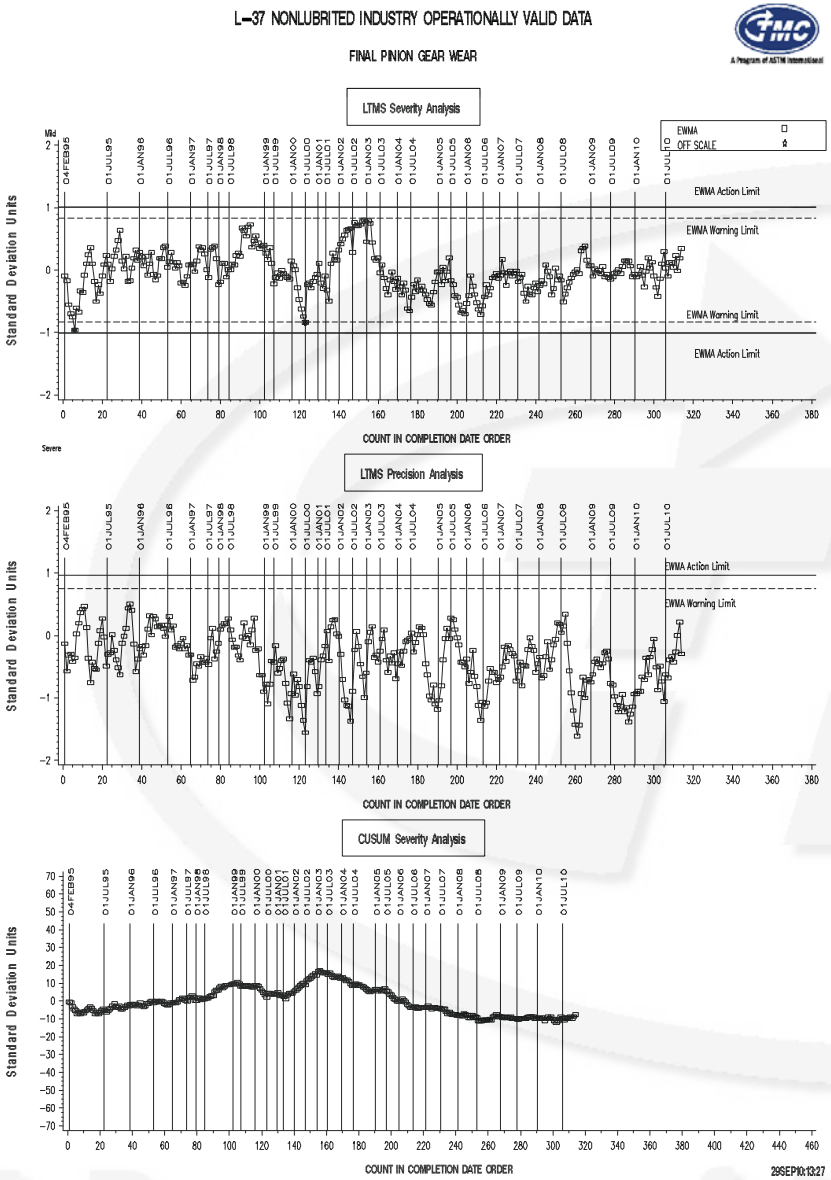
Untransformed



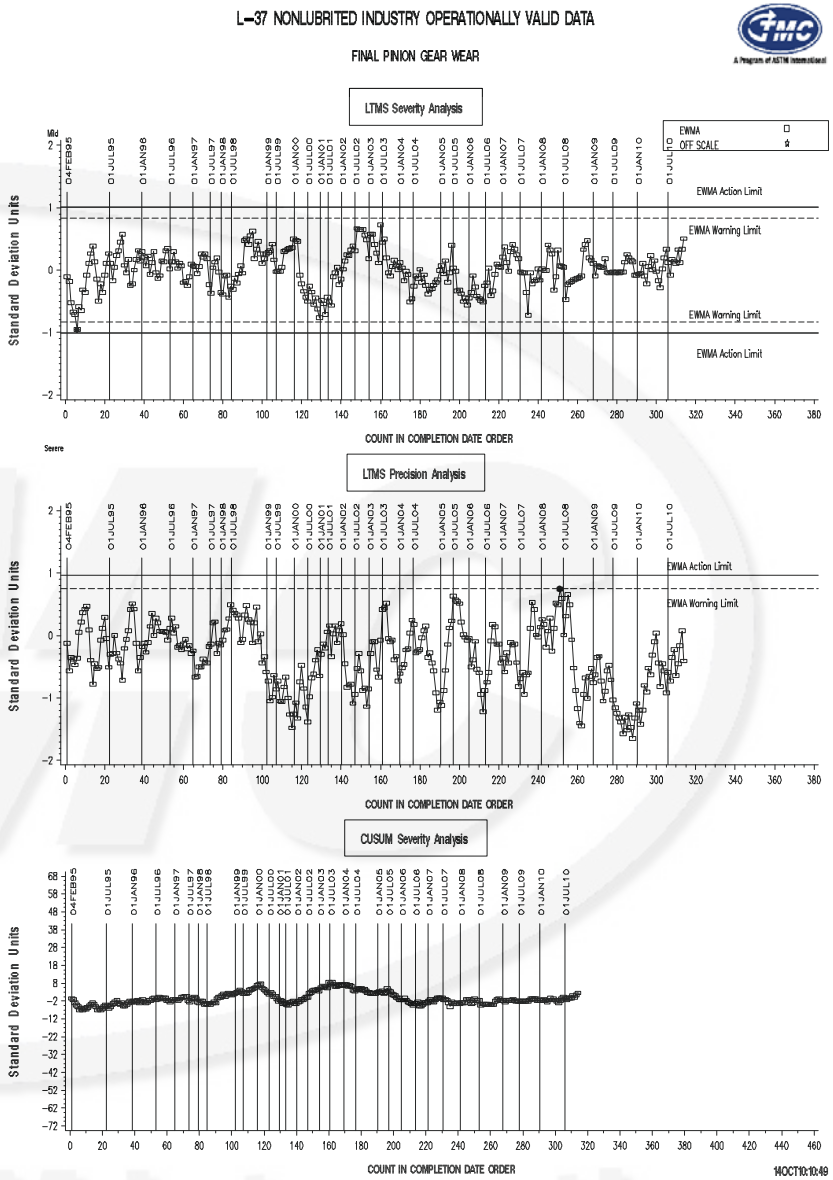
	①	②	③
Target	9.56	9.44	9.65
STD	1.314	1.782	1.232
Rating	5	3	4
Yi(transformed)	-15.7	-29.5	-7.0
Yi(untransformed)	-3.47	-3.6	-4.6

Transformed vs Untransformed L37

Transformed



Untransformed



Untransformed L37 Targets

				Ridging			Rippling			Spitting			Wear		
			n	x	s	Bands	x	s	Bands	x	s	Bands	x	s	Bands
LUBRITED	C1L308	128	15	6.53	1.407	4 - 9	7.63	1.420	5 - 10	8.83	1.754	6 - 10	5.60	1.298	3 - 8
		128-1	7	7.00	0.000	7 - 7	8.00	0.577	7 - 9	8.84	1.723	6 - 10	5.57	0.535	5 - 7
		129	5	9.00	0.000	9 - 9	8.40	0.894	7 - 10	9.56	0.089	9.4 - 9.7	6.80	1.483	4 - 9
	C1L426	128	7	7.57	0.976	6 - 9	8.29	1.380	6 - 10	6.83	2.357	3 - 10	5.71	0.488	5 - 7
		128-1	7	7.71	1.113	6 - 10	7.86	0.690	7 - 9	7.57	3.187	2 - 10	6.00	0.577	5 - 7
		129	2	9.00	0.000	9 - 9	9.50	0.707	8 - 10	9.60	0.141	9.3 - 9.9	7.50	0.707	6 - 9
	L247	128-1	10	7.40	0.516	6 - 8	7.60	1.075	6 - 10	9.02	0.892	7 - 10	5.80	0.422	5 - 7
		151-3	10	8.80	0.422	8 - 10	8.60	0.516	8 - 10	9.49	0.586	8 - 10	6.00	0.000	6 - 6
		155	1	9.00	0.000	9 - 9	8.00	0.000	8 - 8	9.30	0.000	9.3 - 9.3	6.00	0.000	6 - 6
	V1L303	128	1	7.00	0.000	7 - 7	7.00	0.000	7 - 7	8.00	0.000	8 - 8	6.00	0.000	6 - 6
		128-1	30	7.30	1.264	5 - 10	6.97	1.497	4 - 10	5.26	3.144	0 - 10	5.67	0.959	4 - 7
		129	9	8.11	0.601	7 - 9	8.56	0.527	8 - 10	9.61	0.366	9 - 10	6.56	0.527	6 - 8
	V1L686	128-1	20	6.35	0.813	5 - 8	7.20	1.473	5 - 10	9.77	0.421	9.0 - 10	6.40	0.598	5 - 7
		151-3	21	6.43	1.207	4 - 9	8.71	0.463	8 - 10	9.68	0.632	9 - 10	6.57	0.598	5 - 8
		152	4	5.25	0.500	4 - 6	8.25	0.500	7 - 9	9.53	0.359	9 - 10	6.25	0.500	5 - 7
		153	2	5.00	0.000	5 - 5	8.00	0.000	8 - 8	9.30	0.424	9 - 10	5.50	0.707	4 - 7
		155	1	7.00	0.000	7 - 7	9.00	0.000	9 - 9	9.90	0.000	9.9 - 9.9	7.00	0.000	7 - 7
NONLUBRITED	C1L308	127	17	6.41	2.033	3 - 10	6.06	1.784	3 - 9	9.54	0.450	9 - 10	6.82	2.038	3 - 10
		128	30	7.93	0.980	6 - 10	5.90	2.426	2 - 10	9.71	0.306	9.2 - 10	6.37	0.718	5 - 8
		128-1	8	8.38	0.744	7 - 10	5.75	1.982	2 - 9	9.43	0.883	8 - 10	6.50	0.535	6 - 7
		128-2	1	8.00	0.000	8 - 8	6.00	0.000	6 - 6	8.00	0.000	8 - 8	6.00	0.000	6 - 6
		129	19	9.26	0.933	8 - 10	9.89	0.315	9 - 10	9.89	0.091	9.7 - 10	8.11	0.875	7 - 10
	C1L426	127	10	7.25	1.752	4 - 10	8.30	1.767	5 - 10	9.40	1.039	8 - 10	6.50	0.972	5 - 8
		128	10	7.90	0.738	7 - 9	8.20	0.789	7 - 10	9.21	0.998	7 - 10	5.80	0.422	5 - 7
		128-1	11	8.36	0.674	7 - 10	8.00	1.095	6 - 10	9.54	0.785	8 - 10	5.73	0.467	5 - 7
		128-2	2	8.00	0.000	8 - 8	7.50	0.707	6 - 9	9.90	0.000	9.9 - 9.9	6.00	0.000	6 - 6
		129	8	9.50	0.535	9 - 10	9.75	0.463	9 - 10	9.96	0.052	9.9 - 10	7.00	1.195	5 - 9
	V1L176	127	2	7.00	2.828	2 - 10	8.00	0.000	8 - 8	6.45	4.879	0 - 10	6.00	1.414	3 - 9
		128-1	12	8.25	0.754	7 - 10	7.17	2.038	4 - 10	9.72	0.208	9.3 - 10	6.08	0.289	6 - 7
		128-2	1	7.00	0.000	7 - 7	9.00	0.000	9 - 9	9.90	0.000	9.9 - 9.9	6.00	0.000	6 - 6
		151-3	14	9.14	0.363	8 - 10	8.86	0.363	8 - 10	9.56	1.314	7 - 10	6.64	0.633	6 - 8
	V1L303	127	3	6.67	1.155	5 - 9	6.67	2.082	3 - 10	9.80	0.173	9.5 - 10	6.00	0.000	6 - 6
		128-1	13	8.08	0.494	7 - 9	6.92	1.656	4 - 10	8.07	2.451	4 - 10	5.85	0.376	5 - 7
		129	4	9.50	0.577	8 - 10	9.00	0.816	8 - 10	9.93	0.050	9.8 - 10	6.75	0.957	5 - 8
	V1L351	151-3	5	9.20	1.304	7 - 10	9.20	0.447	8 - 10	9.92	0.045	9.8 - 10	7.00	1.000	5 - 9
		152	5	9.40	0.548	8 - 10	8.80	0.447	8 - 10	9.88	0.045	9.8 - 10	7.20	0.837	6 - 9
		153	9	7.22	0.972	5 - 9	7.22	0.972	5 - 9	9.62	0.618	9 - 10	6.44	0.726	5 - 8
		155	3	9.33	0.577	8 - 10	8.67	0.577	8 - 10	9.90	0.000	9.9 - 9.9	7.00	1.000	5 - 9
	V1L417	151-3	23	9.39	0.499	8 - 10	9.35	0.487	8 - 10	9.65	1.232	7 - 10	8.04	0.475	7 - 9
		152	6	9.17	0.408	8 - 10	9.17	0.408	8 - 10	9.90	0.000	9.9 - 9.9	8.00	0.632	7 - 9
		152-1	15	9.47	0.640	8 - 10	9.40	0.507	8 - 10	9.44	1.782	6 - 10	8.00	0.378	7 - 9
		153	4	9.00	0.816	8 - 10	8.25	0.500	7 - 9	9.88	0.050	9.8 - 10	7.50	0.577	6 - 9
		153-1	20	8.80	0.616	8 - 10	8.90	0.447	8 - 10	9.89	0.049	9.8 - 10	7.55	0.605	6 - 9
		155	10	9.50	0.527	9 - 10	9.60	0.516	9 - 10	9.90	0.000	9.9 - 9.9	8.00	0.000	8 - 8
	V1L500	152-1	6	9.00	0.894	7 - 10	9.67	0.516	9 - 10	9.90	0.000	9.9 - 9.9	7.50	0.548	7 - 8
		155	8	9.38	0.518	8 - 10	9.50	0.535	9 - 10	9.84	0.141	9.6 - 10	7.38	0.518	6 - 8
	V1L686	127	9	7.00	2.000	3 - 10	7.56	1.236	5 - 10	9.71	0.643	9 - 10	6.67	0.500	6 - 8
		128-1	8	7.50	0.926	6 - 9	5.63	1.188	3 - 8	9.93	0.046	9.8 - 10	6.88	0.641	6 - 8
		129	2	9.50	0.707	8 - 10	10.00	0.000	10 - 10	10.00	0.000	10 - 10	8.00	1.414	5 - 10
		151-2	11	9.09	0.701	8 - 10	8.73	0.647	8 - 10	9.92	0.040	9.8 - 10	7.55	0.688	6 - 9
		151-3	1	9.00	0.000	9 - 9	8.00	0.000	8 - 8	9.90	0.000	9.9 - 9.9	7.00	0.000	7 - 7

Current hardware/oils are shaded

Untransformed Targets for Current Hardware/Oils

				Ridging					Rippling					Spitting					Wear				
						shewhart					shewhart					shewhart					shewhart			
			n	x	s	min	max	band	x	s	min	max	band	x	s	min	max	band	x	s	min	max	band
NONLUBRITED	V1L417	151-3	30	9.47	0.507	9	10	9-10	9.33	0.606	8	10	8-10	9.71	1.080	7.769	11.657	8-10	8.00	0.587	7	9	7-9
		152-1	15	9.47	0.640	8	11	8-10	9.40	0.507	8	10	8-10	9.44	1.782	6.232	12.648	6-10	8.00	0.378	7	9	7-9
		153-1	20	8.80	0.616	8	10	8-10	8.90	0.447	8	10	8-10	9.89	0.049	9.797	9.973	9.8-10	7.55	0.605	6	9	6-9
		155	10	9.50	0.527	9	10	9-10	9.60	0.516	9	11	9-10	9.90	**0.000**	9.900	9.900	**9.8-10***	8.00	**0.000**	8	8	**7-9***
	V1L500	152-1	13	8.85	0.689	8	10	8-10	9.39	0.506	8	10	8-10	9.89	0.028	9.842	9.942	9.8-9.9	7.46	0.519	7	8	7-8
		155	15	9.07	0.594	8	10	8-10	9.33	0.488	8	10	8-10	9.84	0.124	9.617	10.063	9.6-10	7.47	0.516	7	8	7-8
minimum std for targets generated for all non-current batches:															0.040					0.289			

*bands for these s=0 parameters were computed using the minimum std.
data included: chart = Y or val = AG up to 30 tests