26. L-37 LTMS Requirements

The following are the specific L-37 calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Pinion Ridging, Pinion Rippling, Pinion Pitting/Spalling, Pinion Wear, and Pinion Scoring. The non-critical parameters are Ring Ridging, Ring Rippling, Ring Pitting/Spalling, Ring Wear, and Ring Scoring. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM L-37 Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

RIDGING
Non-lubrited Test Hardware
Unit of Measure: -ln(10.5-Merits)

Reference Oil	Pinion/Ring	Pinion (Critical)		Ring (Non-critical)	
		Mean	Standard Dev.	Mean	Standard Dev.
128	C1L308/P4L318R	-0.866	0.3560	0.038	0.6147
	C1L426/P4L415A	-0.887	0.3204	-0.223	0.5857
128-1	C1L308/P4L318R	-0.827	0.3419	0.038	0.6147
	C1L426/P4L415A	-0.819	0.6407	-0.223	0.5857
	V1L303/P4L514A	-0.928	0.2910	-0.613	0.3607
	V1L686/P4L626A	-0.982	0.3226	-0.308	0.5377
	V1L176/P4L741A	-0.789	0.3247	-0.212	0.6348
128-2	C1L308/P4L318R	-0.827	0.3419	0.038	0.6147
	C1L426/P4L415A	-0.819	0.6407	-0.223	0.5857
	V1L303/P4L514A	-0.928	0.2910	-0.613	0.3607
	V1L686/P4L626A	-0.982	0.3226	-0.308	0.5377
	V1L176/P4L741A	-0.789	0.3247	-0.212	0.6348
152	V1L351/P4T771	0.007	0.6322	0.693	0.4821
	V1L417/P4L792	0.146	0.5031	0.635	0.2520
152-1	V1L417/P4L792	0.146	0.5031	0.635	0.2520
	V1L500/P4LT813	-0.597	0.4827	0.693	0.1879
153	V1L351/P4T771	-0.706	0.6322	-0.195	0.4821
	V1L417/P4L792	-0.339	0.3350	0.067	0.6643
153-1	V1L417/P4L792	-0.339	0.3350	0.067	0.6643
155	V1L686/P4L626A	-0.131	0.5211	0.271	0.5377
	V1L176/P4L741A	-0.237	0.5170	0.512	0.4644
	V1L351/P4T771	0.007	0.6322	0.693	0.4821
	V1L417/P4L792	0.418	0.5676	0.693	0.3747
	V1L500/P4LT813	-0.533	0.4290	0.693	0.0010

RIPPLING
Non-lubrited Test Hardware
Unit of Measure: -ln(10.5-Merits)

Reference Oil	Pinion/Ring	Pinion (Critical)		Ring (Non-critical)	
		Mean	Standard Dev.	Mean	Standard Dev.
128	C1L308/P4L318R	-1.320	0.5627	0.402	0.5661
	C1L426/P4L415A	-0.580	0.5561	0.556	0.3636
128-1	C1L308/P4L318R	-1.348	0.5420	0.402	0.5661
	C1L426/P4L415A	-0.708	0.5078	0.556	0.3636
	V1L303/P4L514A	-1.061	0.6113	0.161	0.5318
	V1L686/P4L626A	-0.933	0.5500	0.327	0.5075
	V1L176/P4L741A	-1.042	0.6358	0.286	0.5406
128-2	C1L308/P4L318R	-1.348	0.5420	0.402	0.5661
	C1L426/P4L415A	-0.708	0.5078	0.556	0.3636
	V1L303/P4L514A	-1.061	0.6113	0.161	0.5318
	V1L686/P4L626A	-0.933	0.5500	0.327	0.5075
	V1L176/P4L741A	-1.042	0.6358	0.286	0.5406
152	V1L351/P4T771	-0.396	0.5304	-0.131	0.5355
	V1L417/P4L792	-0.054	0.4795	0.319	0.5759
152-1	V1L417/P4L792	-0.054	0.4795	0.319	0.5759
	V1L500/P4LT813	-0.268	0.5340	0.281	0.4342
153	V1L351/P4T771	-0.696	0.5304	0.007	0.5355
	V1L417/P4L792	-0.580	0.4079	0.309	0.5376
153-1	V1L417/P4L792	-0.580	0.4079	0.309	0.5376
155	V1L686/P4L626A	-0.502	0.6585	0.231	0.5075
	V1L176/P4L741A	-0.121	0.4696	-0.092	0.5086
	V1L351/P4T771	-0.469	0.5304	0.007	0.5355
	V1L417/P4L792	0.016	0.5300	0.144	0.5230
	V1L500/P4LT813	-0.268	0.5340	0.281	0.2050

PITTING/SPALLING
Non-lubrited Test Hardware
Unit of Measure: -ln(10.5-Merits)

Reference Oil	Pinion/Ring	Pinion (Critical)		Ring (Non-critical)	
		Mean	Standard Dev.	Mean	Standard Dev.
128	C1L308/P4L318R	0.296	0.3105	0.547	0.2060
	C1L426/P4L415A	-0.039	0.4983	0.614	0.1241
128-1	C1L308/P4L318R	0.294	0.3629	0.547	0.2060
	C1L426/P4L415A	0.042	0.5712	0.614	0.1241
	V1L303/P4L514A	-0.879	0.9203	0.333	0.4323
	V1L686/P4L626A	0.311	0.5589	0.574	0.2189
	V1L176/P4L741A	0.355	0.3035	0.517	0.3141
128-2	C1L308/P4L318R	0.294	0.3629	0.547	0.2060
	C1L426/P4L415A	0.042	0.5712	0.614	0.1241
	V1L303/P4L514A	-0.879	0.9203	0.333	0.4323
	V1L686/P4L626A	0.311	0.5589	0.574	0.2189
	V1L176/P4L741A	0.355	0.3035	0.517	0.3141
152	V1L351/P4T771	0.534	0.1703	0.579	0.1220
	V1L417/P4L792	0.541	0.0846	0.570	0.1028
152-1	V1L417/P4L792	0.541	0.0846	0.570	0.1028
	V1L500/P4LT813	0.492	0.3766	0.514	0.1065
153	V1L351/P4T771	0.303	0.2700	0.493	0.1220
	V1L417/P4L792	0.463	0.1335	0.524	0.1028
153-1	V1L417/P4L792	0.463	0.1335	0.524	0.1028
155	V1L686/P4L626A	0.556	0.1033	0.609	0.2189
	V1L176/P4L741A	0.399	0.5287	0.598	0.0933
	V1L351/P4T771	0.498	0.1703	0.537	0.1220
	V1L417/P4L792	0.556	0.3463	0.579	0.1002
	V1L500/P4LT813	0.441	0.0930	0.4470	0.1208

WEAR
Non-lubrited Test Hardware
Unit of Measure: Merits

Reference Oil	Pinion/Ring	Pinion (Critical)		Ring (Non-critical)	
		Mean	Standard Dev.	Mean	Standard Dev.
128	C1L308/P4L318R	6.37	0.761	7.94	0.757
	C1L426/P4L415A	5.67	0.671	7.54	0.623
128-1	C1L308/P4L318R	6.42	0.665	7.94	0.757
	C1L426/P4L415A	5.70	0.641	7.54	0.623
	V1L303/P4L514A	6.00	0.560	7.00	0.779
	V1L686/P4L626A	6.40	0.637	7.42	0.999
	V1L176/P4L741A	6.44	0.801	7.78	0.892
128-2	C1L308/P4L318R	6.42	0.665	7.94	0.757
	C1L426/P4L415A	5.70	0.641	7.54	0.623
	V1L303/P4L514A	6.00	0.560	7.00	0.779
	V1L686/P4L626A	6.40	0.637	7.42	0.999
	V1L176/P4L741A	6.44	0.801	7.78	0.892
152	V1L351/P4T771	7.50	0.948	7.88	0.741
	V1L417/P4L792	8.16	0.565	7.79	0.713
152-1	V1L417/P4L792	8.16	0.565	7.79	0.713
	V1L500/P4LT813	7.38	0.587	8.00	1.119
153	V1L351/P4T771	7.00	0.948	7.25	0.741
	V1L417/P4L792	7.60	0.778	7.55	0.686
153-1	V1L417/P4L792	7.60	0.778	7.55	0.686
155	V1L686/P4L626A	7.63	0.512	8.08	0.999
	V1L176/P4L741A	6.67	0.577	7.95	0.805
	V1L351/P4T771	6.88	0.948	7.75	0.741
	V1L417/P4L792	7.88	0.850	8.00	0.771
	V1L500/P4LT813	7.50	0.503	7.88	0.417

		153	25%
	L247/T758A	128-1	33.3%
		128-2	33.3%
		155	33.3%
Non-Lubrited	C1L308/P4L318R	128-1	100%
		128-2	
	C1L426/P4L415A	128-1	100%
		128-2	
	V1L303/P4L514A	128-1	100%
		128-2	
	V1L686/P4L626A	128-1	50%
		128-2	
		155	50%
		155	
	V1L176/P4L741A	128-1	50%
		128-2	
		155	50%
	V1L351/P4T771	155	50%
		152	25%
		153	25%
	V1L417/P4L792	155	50%
		152	25%
		153	25%
	V1L500/P4LT813	152-1	50%
		155	50%

4. Control Charts.

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. The constants used for the construction of the control charts for the L-37, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all critical parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Warning	0.2	--	2.24	--	--	1.80
	Action	0.2	0.2	2.81	1.96	2.10	1.80
Lab	Action	0.2	0.2	2.81	3.03	--	1.80
Industry	Warning	0.2	0.2	2.24	2.49	--	--
	Action	0.2	0.2	2.88	3.03	--	--

The following are the steps that must be taken in the case of exceeding control chart limits.

- Exceed EWMA test stand chart action limit for precision (critical parameters only)
  - Remove test stand from the system. Notify the TMC. Correct test stand precision problem. Follow requirements for entry of a new test stand into the system.
- Exceed EWMA test stand chart warning limit for precision (critical parameters only)
  - Immediately begin two calibration tests on the test stand.
- Exceed Shewhart test stand chart limit for precision (critical parameters only)
  - Conduct an additional calibration test.
- Exceed EWMA laboratory chart limit for precision or severity (critical parameters only)
  - Notify the TMC for guidance.
- Exceed EWMA test stand chart action limit for severity (all parameters noted below)
  - Calculate test stand Severity Adjustment (SA) for each parameter that exceeds action limit, using the current test stand EWMA (Z_i) as follows:

    Non-lubrited Test Hardware:

Pinion Ridging (Transformed Scale):	$SA = (-Z_i) \times (0.5323)$
Pinion Rippling (Transformed Scale):	$SA = (-Z_i) \times (0.3480)$
Pinion Pitting/Spalling (Transformed Scale):	$SA = (-Z_i) \times (0.4603)$
Pinion Wear:	$SA = (-Z_i) \times (0.694)$

    Lubrited Test Hardware:

Pinion Ridging (Transformed Scale):	$SA = (-Z_i) \times (0.2612)$
Pinion Rippling (Transformed Scale):	$SA = (-Z_i) \times (0.2341)$
Pinion Pitting/Spalling (Transformed Scale):	$SA = (-Z_i) \times (0.4038)$
Pinion Wear:	$SA = (-Z_i) \times (0.548)$

  - Confirm calculations with the TMC.
  - SA calculations are for information purposes only.
- Exceed Shewhart test stand chart limit for severity (critical parameters only)
  - Conduct an additional calibration test.

The following industry issues are handled by the TMC and do not require individual laboratory action.

- Exceed EWMA industry chart action limit (critical parameters only)

  – TMC to notify surveillance panel chairman. Meeting of the TMC and the surveillance panel required to determine course of action.

- Exceed EWMA industry chart warning limit (critical parameters only)

  – TMC to notify surveillance panel chairman. Coordination of TMC and surveillance panel required to discuss potential problem.

29. High Temperature Cyclic Durability Test LTMS Requirements

The following are the specific High Temperature Cyclic Durability calibration test requirements.

A. Reference Oils and Critical Parameter

The critical parameter is Cycles to Unsychronized Shifts. The reference oils required for test stand and test laboratory calibration are the reference oils accepted by the ASTM High Temperature Cyclic Durability Test Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameter are presented below.

CYCLES TO UNSYCHRONIZED SHIFTS
Unit of Measure: Cycles

Reference Oil	Mean	Standard Deviation
150-2	24271	4623
151-3	74489	9662
155	74489	9662

B. Acceptance Criteria

1. New Test Stand

- A minimum of three (3) operationally valid calibration tests, with no stand Shewhart severity alarms, must be conducted. Two (2) tests must be conducted on reference oils 151 or 155 or subsequent approved reblends, and one (1) test must be conducted on reference oil 150 or subsequent approved reblends.

2. Existing Test Stand

- The test stand must have been TMC calibrated prior to LTMS introduction or previously accepted into the system by meeting LTMS calibration requirements.

- A test stand must complete one test on reference oil 151 or 155, or subsequent approved reblends, with no stand Shewhart severity alarm.

- Every other calibration sequence, a test stand must complete one test on reference oil 151 or 155, or subsequent approved reblends, and one test on reference oil 150, or subsequent approved reblends, with both tests having no stand Shewhart severity alarms. The only exception would be if reference oil 150, or subsequent reblends fails in the severe direction.

3. Reference Oil Assignment

Once test stands have been accepted into the system, the TMC will assign reference oils for continuing calibration according to the following reference oil mix:

- 100% of the scheduled calibration tests should be conducted on reference oils 150, 151, and 155, or subsequent approved reblends.

- See Sections 1 and 2 above for detailed oil assignment instructions.

4. Control Charts

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. The constants used for the construction of the control charts for the High Temperature Cyclic Durability Test, and the response necessary in the case of control limit alarms, are depicted below.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Action	--	--	--	--	--	1.96
Industry	Warning	0.2	0.3	1.46	1.80	--	--
	Action	0.2	0.3	2.33	2.58	--	--

The following are the steps that must be taken in the case of exceeding control chart limits.

- Exceed Shewhart test stand chart limit for severity (all parameters)

– For reference oils 151 and 155 or subsequent reblends, conduct an additional calibration test.

– For reference oil 150 or subsequent reblends, conduct an additional calibration test only if the test exceeds the Shewhart limit in the mild direction.

The following industry issues are handled by the TMC and do not require individual laboratory action.

- Exceed EWMA industry chart action limit

  – TMC to notify test developer and surveillance panel chairman. Meeting of TMC, test developer, and surveillance panel chairman required to determine course of action.

- Exceed EWMA industry chart warning limit

  – TMC to notify test developer and surveillance panel chairman. Coordination of TMC, test developer, and surveillance panel chairman required to discuss potential problem.

L-37 Reference Oil Transformed Targets – Pinion (Continued)													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	n	Gear Type	Pinion/Ring	From	To[1]	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
151-2	8	Non-lubrited	V1L686/P4L626A	5-9-00	***	-0.131	0.5211	-0.502	0.6585[3]	0.556	0.1033	7.63	0.512
151-3	--[5]	Non-lubrited	V1L686/P4L626A	8-29-01	***	-0.131	0.5211	-0.502	0.6585[3]	0.556	0.1033	7.63	0.512
	8	Non-lubrited	V1L176/P4L741A	11-25-02	5-18-05	-0.237	0.5347	-0.121	0.4696	0.462	0.1379	6.62	0.644
	21	Non-lubrited	V1L176/P4L741A	5-19-05	***	-0.237	0.5170[3]	-0.121[6]	0.4696[6]	0.399	0.5287	6.67	0.577
	8	Non-lubrited	V1L351/P4T771	2-4-05	***	0.007	0.6322	-0.469	0.5304	0.498	0.1703	6.88	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	0.418	0.5676	0.016	0.5300	0.556	0.3463	7.88	0.850
	25	Non-lubrited	V1L417/P4L792	9-10-08	***	0.166	0.5867	0.037	0.4141	0.535	0.0990[3]	7.96	0.586
152	8	Non-lubrited	V1L351/P4T771	2-4-05	***	0.007	0.6322	-0.396	0.5304	0.534	0.1703	7.50	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	0.418	0.5573	0.016	0.6185	0.579	0.0880	8.38	0.870
	19	Non-lubrited	V1L417/P4L792	9-10-08	***	0.146	0.5031	-0.054	0.4795[3]	0.541	0.0846[3]	8.16	0.565
152-1	--[7]	Non-lubrited	V1L417/P4L792	9-10-08	***	0.146	0.5031	-0.054	0.4795	0.541	0.0846	8.16	0.565
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	-0.597	0.4827	-0.268	0.5340[3]	0.492	0.3766	7.38	0.587
153	8	Non-lubrited	V1L351/P4T771	2-4-05	***	-0.706	0.6322	-0.696	0.5304	0.303	0.2700[3]	7.00	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	-0.322	0.6775	-0.524	0.6114	0.174	0.5523	7.88	0.991
	20	Non-lubrited	V1L417/P4L792	9-10-08	***	-0.339	0.3350	-0.580	0.4079	0.463	0.1335[3]	7.60	0.778[3]
153-1	--[8]	Non-lubrited	V1L417/P4L792	9-10-08	***	-0.339	0.3350	-0.580	0.4079	0.463	0.1335	7.60	0.778
155	--[9]	Non-lubrited	V1L686/P4L626A	2-8-06	***	-0.131	0.5211	-0.502	0.6585	0.556	0.1033	7.63	0.512
	--[9]	Non-lubrited	V1L176/P4L741A	2-8-06	***	-0.237	0.5170	-0.121	0.4696	0.399	0.5287	6.67	0.577
	--[9]	Non-lubrited	V1L351/P4T771	2-8-06	***	0.007	0.6322	-0.469	0.5304	0.498	0.1703	6.88	0.948
	--[9]	Non-lubrited	V1L417/P4L792	5-10-06	***	0.418	0.5676	0.016	0.5300	0.556	0.3463	7.88	0.850
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	-0.533	0.4290	-0.268	0.5340[3]	0.441	0.0903	7.50	0.503

1 *** = currently in effect
2 Transformation is -ln(10.5-Rating)
3 Standard deviation modified to expand Shewhart band
4 Targets based on oil 128-1
5 Initial targets based on oil 151-2
6 Used previous targets (n=8)
7 Targets based on oil 152
8 Targets based on oil 153
9 Targets based on oil 151-3

L-37 Reference Oil Transformed Targets - Ring													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	n	Gear Type	Pinion/Ring	From	To[1]	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
127	17	Non-lubrited	C1L308/P4L318R	8-29-01	***	-0.992	0.6997	0.405	0.5772	0.481	0.2213	7.59	1.276
	9	Non-lubrited	C1L426/P4L415A	8-29-01	***	-0.741	0.5377	0.693	0.5075	0.580	0.2189	7.89	0.999
	8	Non-lubrited	V1L303/P4L514A	8-29-01	***	-1.063	0.5377	-0.167	0.5075	0.451	0.2189	6.98	0.999
	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	-0.873	0.5377	-0.207	0.5075	0.511	0.2189	6.77	0.999
	8	Non-lubrited	V1L176/P4L741A	2-25-03	***	-0.861	0.6411	0.006	0.6304	0.429	0.1911	7.00	1.108
128	36	Non-lubrited	C1L308/P4L318R	8-29-01	***	0.038	0.6147	0.402	0.5661	0.547	0.2060	7.94	0.757
	24	Non-lubrited	C1L426/P4L415A	8-29-01	***	-0.223	0.5857	0.556	0.3636	0.614	0.1241	7.54	0.623
128-1	36	Non-lubrited	C1L308/P4L318R	8-29-01	***	0.038	0.6147	0.402	0.5661	0.547	0.2060	7.94	0.757
	24	Non-lubrited	C1L426/P4L415A	8-29-01	***	-0.223	0.5857	0.556	0.3636	0.614	0.1241	7.54	0.623
	14	Non-lubrited	V1L303/P4L514A	8-29-01	***	-0.591	0.5377	0.202	0.5075	0.321	0.2189	7.00	0.999
	12	Non-lubrited	V1L686/P4L626A	8-29-01	***	-0.308	0.5377	0.327	0.5075	0.574	0.2189	7.42	0.999
	16	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	-0.322	0.6472	0.212	0.5629	0.462	0.3920	7.75	1.065
	27	Non-lubrited	V1L176/P4L741A	5-19-05	***	-0.212	0.6348	0.286	0.5406	0.517	0.3141	7.78	0.892
128-2[3]	--	Non-lubrited	C1L308/P4L318R	8-29-01	***	0.038	0.6147	0.402	0.5661	0.547	0.2060	7.94	0.757
	--	Non-lubrited	C1L426/P4L415A	8-29-01	***	-0.223	0.5857	0.556	0.3636	0.614	0.1241	7.54	0.623
	--	Non-lubrited	V1L303/P4L514A	8-29-01	***	-0.591	0.5377	0.202	0.5075	0.321	0.2189	7.00	0.999
	--	Non-lubrited	V1L686/P4L626A	8-29-01	***	-0.308	0.5377	0.327	0.5075	0.574	0.2189	7.42	0.999
	--	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	-0.322	0.6472	0.212	0.5629	0.462	0.3920	7.75	1.065
	--	Non-lubrited	V1L176/P4L741A	5-19-05	***	-0.212	0.6348	0.286	0.5406	0.517	0.3141	7.78	0.892
151-2	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	0.271	0.5377	0.231	0.5075	0.609	0.2189	8.08	0.999
151-3	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	0.271	0.5377	0.231	0.5075	0.609	0.2189	8.08	0.999
	8	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	0.355	0.4400	0.144	0.4179	0.602	0.0976	7.75	0.571
	21	Non-lubrited	V1L176/P4L741A	5-19-05	***	0.512	0.4644	-0.092	0.5086	0.598	0.0933	7.95	0.805
	8	Non-lubrited	V1L351/P4T771	2-4-05	***	0.693	0.4821	0.007	0.5355	0.537	0.1220	7.75	0.741
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	0.693	0.3747	0.144	0.5230	0.579	0.1002	8.00	0.771
	25	Non-lubrited	V1L417/P4L792	9-10-08	***	0.973	1.4000	0.166	0.5602	0.562	0.0835	7.84	0.800
152	8	Non-lubrited	V1L351/P4T771	2-4-05	***	0.693	0.4821	-0.131	0.5355	0.579	0.1220	7.88	0.741

L-37 Reference Oil Transformed Targets – Ring (Continued)													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	N	Gear Type	Pinion/Ring	From	To[1]	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	S	$\bar{X}$	S
152	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	0.693	0.1590	0.281	0.5462	0.583	0.1695	7.88	0.834
	19	Non-lubrited	V1L417/P4L792	9-10-08	***	0.635	0.2520	0.319	0.5759	0.570	0.1028	7.79	0.713
152-1	--[4]	Non-lubrited	V1L417/P4L792	9-10-08	***	0.635	0.2520	0.319	0.5759	0.570	0.1028	7.79	0.713
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	0.693	0.1879	0.281	0.4342	0.514	0.1065	8.00	1.119
153	8	Non-lubrited	V1L351/P4T771	2-4-05	***	-0.195	0.4821	0.007	0.5355	0.493	0.1220	7.25	0.741
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	0.016	0.7322	0.144	0.5636	0.560	0.1663	7.75	0.697
	20	Non-lubrited	V1L417/P4L792	9-10-08	***	0.067	0.6643	0.309	0.5376	0.524	0.1028	7.55	0.686
153-1	--[5]	Non-lubrited	V1L417/P4L792	9-10-08	***	0.067	0.6643	0.309	0.5376	0.524	0.1028	7.55	0.686
155	--[6]	Non-lubrited	V1L686/P4L626A	2-8-06	***	0.271	0.5377	0.231	0.5075	0.609	0.2189	8.08	0.999
	--[6]	Non-lubrited	V1L176/P4L741A	2-8-06	***	0.512	0.4644	-0.092	0.5086	0.598	0.0933	7.95	0.805
	--[6]	Non-lubrited	V1L351/P4T771	2-8-06	***	0.693	0.4821	0.007	0.5355	0.537	0.1220	7.75	0.741
	--[6]	Non-lubrited	V1L417/P4L792	5-10-06	***	0.693	0.3747	0.144	0.5230	0.579	0.1002	8.00	0.771
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	0.693	0.0010	0.281	0.2050	0.447	0.1208	7.88	0.417

1 *** = currently in effect
2 Transformation is -ln(10.5-Rating)
3 Targets based on oil 128-1
4 Targets based on oil 152
5 Targets based on oil 153
6 Targets based on oil 151-3

L-37 Reference Oil Untransformed Targets – Pinion (Continued)													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	n	Gear Type	Pinion/Ring	From	To[1]	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s
151-2	8	Non-lubrited	V1L686/P4L626A	5-9-00	***	9.36	0.5211	8.85	0.6585[4]	9.93	0.1033	7.63	0.512
151-3	--[6]	Non-lubrited	V1L686/P4L626A	8-29-01	***	9.36	0.5211	8.85	0.6585[4]	9.93	0.1033	7.63	0.512
	8	Non-lubrited	V1L176/P4L741A	11-25-02	5-18-05	9.23	0.5347	9.37	0.4696	9.87	0.1379	6.62	0.644
	21	Non-lubrited	V1L176/P4L741A	5-19-05	***	9.23	0.5170[4]	9.37	0.4696[6]	9.83	0.5287	6.67	0.577
	8	Non-lubrited	V1L351/P4T771	2-4-05	***	9.51	0.6322	8.90	0.5304	9.89	0.1703	6.88	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	9.84	0.5676	9.52	0.5300	9.93	0.3463	7.88	0.850
	25	Non-lubrited	V1L417/P4L792	9-10-08	***	9.65	0.5867	9.54	0.4141	9.91	0.0990[4]	7.96	0.586
152	8	Non-lubrited	V1L351/P4T771	2-4-05	***	9.51	0.6322	9.01	0.5304	9.91	0.1703	7.50	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	9.84	0.5573	9.52	0.6185	9.94	0.0880	8.38	0.870
	19	Non-lubrited	V1L417/P4L792	9-10-08	***	9.64	0.5031	9.44	0.4795[4]	9.92	0.0846[4]	8.16	0.565
152-1	--[7]	Non-lubrited	V1L417/P4L792	9-10-08	***	9.64	0.5031	9.44	0.4795	9.92	0.0846	8.16	0.565
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	8.68	0.4827	9.19	0.5340[4]	9.89	0.3766	7.38	0.587
153	8	Non-lubrited	V1L351/P4T771	2-4-05	***	8.47	0.6322	8.49	0.5304	9.76	0.2700[4]	7.00	0.948
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	9.12	0.6775	8.81	0.6114	9.66	0.5523	7.88	0.991
	20	Non-lubrited	V1L417/P4L792	9-10-08	***	9.09	0.3350	8.71	0.4079	9.87	0.1335[4]	7.60	0.778[4]
153-1	--[8]	Non-lubrited	V1L417/P4L792	9-10-08	***	9.09	0.3350	8.71	0.4079	9.87	0.1335	7.60	0.778
155	--[9]	Non-lubrited	V1L686/P4L626A	2-8-06	***	9.36	0.5211	8.85	0.6585	9.93	0.1033	7.63	0.512
	--[9]	Non-lubrited	V1L176/P4L741A	2-8-06	***	9.23	0.5170	9.37	0.4696	9.83	0.5287	6.67	0.577
	--[9]	Non-lubrited	V1L351/P4T771	2-8-06	***	9.51	0.6322	8.90	0.5304	9.89	0.1703	6.88	0.948
	--[9]	Non-lubrited	V1L417/P4L792	5-10-06	***	9.84	0.5676	9.52	0.5300	9.93	0.3463	7.88	0.850
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	8.80	0.4290	9.19	0.5340[4]	9.86	0.0930	7.50	0.503

1 *** = currently in effect
2 Transformation is -ln(10.5-Rating)
3 Mean shown in original units
4 Standard deviation modified to expand Shewhart band
5 Targets based on oil 128-1
6 Targets based on oil 151-2
7 Targets based on oil 152
8 Targets based on oil 153
9 Targets based on oil 151-3

L-37 Reference Oil Untransformed Targets - Ring													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	n	Gear Type	Pinion/Ring	From	To[1]	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s	$\overline{X}$ [3]	s
127	17	Non-lubrited	C1L308/P4L318R	8-29-01	***	7.80	0.6997	9.83	0.5772	9.88	0.2213	7.59	1.276
	9	Non-lubrited	C1L426/P4L415A	8-29-01	***	8.40	0.5377	10.00	0.5075	9.94	0.2189	7.89	0.999
	8	Non-lubrited	V1L303/P4L514A	8-29-01	***	7.60	0.5377	9.32	0.5075	9.86	0.2189	6.98	0.999
	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	8.11	0.5377	9.27	0.5075	9.90	0.2189	6.77	0.999
	8	Non-lubrited	V1L176/P4L741A	2-25-03	***	8.13	0.6411	9.51	0.6304	9.85	0.1911	7.00	1.108
128	36	Non-lubrited	C1L308/P4L318R	8-29-01	***	9.54	0.6147	9.83	0.5661	9.92	0.2060	7.94	0.757
	24	Non-lubrited	C1L426/P4L415A	8-29-01	***	9.25	0.5857	9.93	0.3636	9.96	0.1241	7.54	0.623
128-1	36	Non-lubrited	C1L308/P4L318R	8-29-01	***	9.54	0.6147	9.83	0.5661	9.92	0.2060	7.94	0.757
	24	Non-lubrited	C1L426/P4L415A	8-29-01	***	9.25	0.5857	9.93	0.3636	9.96	0.1241	7.54	0.623
	14	Non-lubrited	V1L303/P4L514A	8-29-01	***	8.69	0.5377	9.68	0.5075	9.77	0.2189	7.00	0.999
	12	Non-lubrited	V1L686/P4L626A	8-29-01	***	9.14	0.5377	9.78	0.5075	9.94	0.2189	7.42	0.999
	16	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	9.12	0.6472	9.69	0.5629	9.87	0.3920	7.75	1.065
	27	Non-lubrited	V1L176/P4L741A	5-19-05	***	9.26	0.6348	9.75	0.5406	9.90	0.3141	7.78	0.892
128-2[4]	--	Non-lubrited	C1L308/P4L318R	8-29-01	***	9.54	0.6147	9.83	0.5661	9.92	0.2060	7.94	0.757
	--	Non-lubrited	C1L426/P4L415A	8-29-01	***	9.25	0.5857	9.93	0.3636	9.96	0.1241	7.54	0.623
	--	Non-lubrited	V1L303/P4L514A	8-29-01	***	8.69	0.5377	9.68	0.5075	9.77	0.2189	7.00	0.999
	--	Non-lubrited	V1L686/P4L626A	8-29-01	***	9.14	0.5377	9.78	0.5075	9.94	0.2189	7.42	0.999
	--	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	9.12	0.6472	9.69	0.5629	9.87	0.3920	7.75	1.065
	--	Non-lubrited	V1L176/P4L741A	5-19-05	***	9.26	0.6348	9.75	0.5406	9.90	0.3141	7.78	0.892
151-2	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	9.74	0.5377	9.71	0.5075	9.96	0.2189	8.08	0.999
151-3	13	Non-lubrited	V1L686/P4L626A	8-29-01	***	9.74	0.5377	9.71	0.5075	9.96	0.2189	8.08	0.999
	8	Non-lubrited	V1L176/P4L741A	2-25-03	5-18-05	9.80	0.4400	9.63	0.4179	9.95	0.0976	7.75	0.571
	21	Non-lubrited	V1L176/P4L741A	5-19-05	***	9.90	0.4644	9.40	0.5086	9.95	0.0933	7.95	0.805
	8	Non-lubrited	V1L351/P4T771	2-4-05	***	10.00	0.4821	9.51	0.5355	9.92	0.1220	7.75	0.741
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	10.00	0.3747	9.63	0.5230	9.94	0.1002	8.00	0.771
	25	Non-lubrited	V1L417/P4L792	9-10-08	***	10.00	1.4000	9.65	0.5602	9.93	0.0835	7.84	0.800
152	8	Non-lubrited	V1L351/P4T771	2-4-05	***	10.00	0.4821	9.36	0.5355	9.94	0.1220	7.88	0.741

L-37 Reference Oil Untransformed Targets – Ring (Continued)													
				Effective Dates		Ridging[2]		Rippling[2]		Pitting/Spalling[2]		Wear	
Oil	N	Gear Type	Pinion/Ring	From	To[1]	$\overline{X}$ [3]	S	$\overline{X}$ [3]	S	$\overline{X}$ [3]	S	$\overline{X}$ [3]	S
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	10.00	0.1590	9.74	0.5462	9.94	0.1695	7.88	0.834
	19	Non-lubrited	V1L417/P4L792	9-10-08	***	9.97	0.2520	9.77	0.5759	9.93	0.1028	7.79	0.713
152-1	--[5]	Non-lubrited	V1L417/P4L792	9-10-08	***	9.97	0.2520	9.77	0.5759	9.93	0.1028	7.79	0.713
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	10.0	0.1879	9.74	0.4342	9.90	0.1065	8.00	1.119
153	8	Non-lubrited	V1L351/P4T771	2-4-05	***	9.28	0.4821	9.51	0.5355	9.89	0.1220	7.25	0.741
	8	Non-lubrited	V1L417/P4L792	5-10-06	9-9-08	9.52	0.7322	9.63	0.5636	9.93	0.1663	7.75	0.697
	20	Non-lubrited	V1L417/P4L792	9-10-08	***	9.56	0.6643	9.77	0.5376	9.91	0.1028	7.55	0.686
153-1[6]	--	Non-lubrited	V1L417/P4L792	9-10-08	***	9.56	0.6643	9.77	0.5376	9.91	0.1028	7.55	0.686
155[7]	--	Non-lubrited	V1L686/P4L626A	2-8-06	***	9.74	0.5377	9.71	0.5075	9.96	0.2189	8.08	0.999
	--	Non-lubrited	V1L176/P4L741A	2-8-06	***	9.90	0.4644	9.40	0.5086	9.95	0.0933	7.95	0.805
	--	Non-lubrited	V1L351/P4T771	2-8-06	***	10.00	0.4821	9.51	0.5355	9.92	0.1220	7.75	0.741
	--	Non-lubrited	V1L417/P4L792	5-10-06	***	10.00	0.3747	9.63	0.5230	9.94	0.1002	8.00	0.771
	8	Non-lubrited	V1L500/P4LT813	1-20-10	***	10.0	0.0010	9.74	0.2050	9.86	0.1208	7.88	0.417

1 *** = currently in effect
2 Transformation is -ln(10.5-Rating)
3 Mean shown in original units
4 Targets based on oil 128-1
5 Targets based on oil 152
6 Targets based on oil 153
7 Targets based on oil 151-3