7. Sequence VG LTMS Requirements

The following are the specific Sequence VG calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Average Engine Sludge, Average Rocker Cover Sludge, Average Engine Varnish, Average Piston Varnish, and Oil Screen Clogging. Number of Hot Stuck Rings is a discrete parameter and is monitored for occurrence only. The reference oils required for stand calibration are the reference oils accepted by the ASTM Sequence VG Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

AVERAGE ENGINE SLUDGE
Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
940	6.43	0.51
1006	8.43	0.60
1006-2	8.65	0.52
1007	8.93	0.30
1009	7.94	0.52

AVERAGE ROCKER COVER SLUDGE
Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
940	8.15	0.92
1006	9.35	0.20
1006-2	9.40	0.34
1007	8.99	0.41
1009	9.29	0.27

AVERAGE ENGINE VARNISH
Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
940	8.79	0.25
1006	9.27	0.10
1006-2	9.24	0.22
1007	9.24	0.11
1009	8.99	0.22

AVERAGE PISTON VARNISH
Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
940	7.20	0.63
1006	8.49	0.18
1006-2	8.52	0.43
1007	8.57	0.23
1009	7.79	0.43

OIL SCREEN CLOGGING
Unit of Measure: LN(OSCRNSLG + 1)

Reference Oil	Mean	Standard Deviation
940	3.951	0.840
1006	1.384	0.850
1006-2	0.896	1.038
1007	0.968	0.614
1009	2.200	1.038

NUMBER OF HOT STUCK RINGS
Unit of Measure: Count

Reference Oil	Maximum Allowable
940	0
1006	0
1006-2	0
1007	0
1009	0

B. Acceptance Criteria

1. New Test Stand

a. Less than six (6) Operationally Valid Calibration Results in Laboratory

- A minimum of two (2) operationally valid calibration tests, with no stand Shewhart severity alarms and no stand Shewhart precision alarms must be conducted on any approved reference oils except 940.

- All operationally valid calibration results must be charted to determine if the test stand is currently “in control” as defined by the control chart from the Lubricant Test Monitoring System.

b. Six (6) or more Operationally Valid Calibration Results in Laboratory*

- The first operationally valid test run on any approved reference oil must have no stand Shewhart severity alarm and no stand Shewhart precision alarm using the "Reduced K" values. If the first operationally valid calibration test does not meet this acceptance criteria, then the New Test Stand criteria listed above in 1.a must be followed.

* Only test results from calibrated stands in the laboratory count towards the tally of six (6) required operationally valid calibration tests. The sixth test must complete (date and time) before the first test completes (date and time) on a new test stand that is seeking calibration with a single test result. In addition, the first test for the stand is to begin within six (6) months of the completion of the last acceptable calibration test. Also, there must not be any outstanding precision alarms for the laboratory.

2. Existing Test Stand

- The test stand must have previously been accepted into the system by meeting LTMS calibration requirements.

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:

- 25% each, oils 940, 1006, 1007, and 1009 (or subsequent reblends).

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 Sequence VG, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all parameters, except Number of Hot Stuck Rings, 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	Reduced K	--	--	--	--	1.48	1.48
	Action	0.30	0.30	1.80	2.10	2.00	2.00
Lab	Warning	0.30	-	1.80	-	-	-
	Action	0.30	0.20	2.24	1.96	2.00	2.00
Industry	Warning	0.15	0.15	1.80	2.10	-	-
	Action	0.15	0.15	2.57	2.81	2.00	2.00

The following are the steps that must be taken in the case of exceeding control chart limits. The steps are listed in order of priority, although charts should be studied simultaneously to

determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance.

- Exceed the EWMA laboratory chart action limit for precision (excludes Oil Screen Clogging)

  – Cease all candidate starts in the laboratory. Develop plan to correct laboratory precision problem. Coordinate efforts with the TMC.

- Exceed EWMA laboratory chart warning limit for precision (excludes Oil Screen Clogging)

  – Immediately begin two (2) calibration tests on calibrated test stands different from the test stand which exceeded the warning limit. (Calibration tests currently running on "existing" test stands may be used.) If a laboratory has two (2) test stands, conduct one (1) calibration test in each of those two (2) stands. If a laboratory has only one (1) test stand, conduct two (2) additional calibration tests in that test stand. Notify the TMC for potential laboratory visit. Candidate testing may continue on other calibrated test stands.

- Exceed EWMA test stand chart limit for precision (excludes Oil Screen Clogging)

  – 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 Shewhart test stand chart limit for precision (excludes Oil Screen Clogging)

  – Conduct an additional calibration test.

- Exceed Shewhart laboratory chart limit for precision (excludes Oil Screen Clogging)

  – Notify TMC for guidance.

- Exceed EWMA laboratory chart limit for severity

  – Calculate laboratory Severity Adjustment (SA) for each parameter that exceeds action limit, using the current laboratory EWMA (Z_i) as follows:

AES:	$SA=(-Z_i) \times (0.45)$*
RCS:	$SA=(-Z_i) \times (0.56)$*
AEV:	$SA=(-Z_i) \times (0.16)$*
APV:	$SA=(-Z_i) \times (0.31)$*
OSCRNSLG (Transformed Scale):	$SA=(-Z_i) \times (0.793)$*

  * Pooled s based on reference oils 1006, 1006-2, 1007, and 1009

  – Confirm calculations with TMC

14. 1P LTMS Requirements

The following are the specific 1P calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Top Groove Carbon, Top Land Carbon and Average Oil Consumption. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Single Cylinder Diesel Surveillance Panel. The means and standard deviations for the current reference oils for each critical and noncritical parameter are presented below.

TOP GROOVE CARBON
Unit of Measure: Demerits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1004-3	29.48	7.74
1005-3	28.65	7.74
1005-4	28.65	7.74

TOP LAND CARBON
Unit of Measure: Demerits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1004-3	28.12	13.15
1005-3	30.88	13.15
1005-4	30.88	13.15

AVERAGE OIL CONSUMPTION
Unit of Measure: LN(g/h)
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1004-3	1.8321	0.3238
1005-3	1.8641	0.3238
1005-4	1.8641	0.3238

WEIGHTED DEMERITS
Unit of Measure: Demerits
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1004-3	319.6	57.6
1005-3	285.3	57.6
1005-4	285.3	57.6

END OF TEST OIL CONSUMPTION
Unit of Measure: LN(g/h)
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1004-3	2.0492	0.5177
1005-3	1.6016	0.5177
1005-4	1.6016	0.5177

B. Acceptance Criteria

1. New Test Stand

a. Less than six (6) Operationally Valid Calibration Results in Laboratory

- A minimum of two (2) operationally valid calibration tests, with no stand Shewhart severity alarms and no stand Shewhart precision alarms, must be conducted on any approved reference oils.

- All operationally valid calibration test results must be charted to determine if the test stand is currently “in control” as defined by the control charts from the Lubricant Test Monitoring System.

b. Six (6) or more Operationally Valid Calibration Results in Laboratory *

- The first operationally valid calibration test run on any approved reference oil must have no stand Shewhart severity alarm and no stand Shewhart precision alarm using the “Reduced K” values. If the first operationally valid calibration test does not meet this acceptance criteria, then the New Test Stand criteria listed above in 1.a must be followed.

* Only test results from calibrated stands in the laboratory count towards the tally of six (6) required operationally valid calibration tests. The sixth test must complete (date and time) before the first test completes (date and time) on a New Test Stand that is seeking calibration with a single test result. In addition, the first test for the stand is to begin within nine (9) months of the completion of the last acceptable calibration test. Also, there must not be any outstanding precision alarms for the laboratory.

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.

   - All operationally valid calibration test results must be charted to determine if the test stand is currently "in control" as defined by the control charts from the Lubricant Test Monitoring System.

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:

   - 80% of the scheduled calibration tests should be conducted on reference oil 1005 or subsequent approved reblend.

   - 20% of the scheduled calibration tests should be conducted on reference oils 1004-3 or subsequent approved reblends.

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 for the control charts for the 1P, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all 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	Reduced K	--	--	--	--	1.66	1.48
	Action	0.3	0.3	1.96	2.24	1.96	1.80
Lab	Warning	0.2	--	1.96	--	--	--
	Action	0.2	0.2	2.72	1.96	1.96	1.80
Industry	Warning	0.2	0.2	2.00	2.24	--	--
	Action	0.2	0.2	2.65	2.88	--	--

The following are the steps that must be taken in the case of exceeding control chart limits. The steps are listed in order of priority, although charts should be studied simultaneously to determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance.

15. 1R LTMS Requirements

The following are the specific 1R calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Weighted Demerits, Top Groove Carbon, and Top Land Carbon. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Single Cylinder Diesel Surveillance Panel. The means and standard deviations for the current reference oils for each critical and noncritical parameter are presented below.

WEIGHTED DEMERITS
Unit of Measure: Demerits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-2	341.2	36.2
1005-3	327.9	23.1
1005-4	327.9	23.1

TOP GROOVE CARBON
Unit of Measure: Demerits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-2	34.11	10.28
1005-3	34.51	8.70
1005-4	34.51	8.70

TOP LAND CARBON
Unit of Measure: Demerits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-2	22.82	10.50
1005-3	18.61	6.00
1005-4	18.61	6.00

INITIAL OIL CONSUMPTION
Unit of Measure: g/h
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-2	8.3	1.7
1005-3	10.0	1.1
1005-4	10.0	1.1

END OF TEST OIL CONSUMPTION
Unit of Measure: g/h
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-2	7.9	2.6
1005-3	8.3	1.0
1005-4	8.3	1.0

B. Acceptance Criteria

1. New Test Stand

a. Less than three (3) Operationally Valid Calibration Results in Laboratory

- A minimum of two (2) operationally valid calibration tests, with no stand Shewhart severity alarms and no stand Shewhart precision alarms, must be conducted on any approved reference oils.

- All operationally valid calibration test results must be charted to determine if the test stand is currently "in control" as defined by the control charts from the Lubricant Test Monitoring System.

b. Three (3) or more Operationally Valid Calibration Results in Laboratory *

- The first operationally valid calibration test run on any approved reference oil must have no stand Shewhart severity alarm and no stand Shewhart precision alarm using the "Reduced K" values. If the first operationally valid calibration test does not meet this acceptance criteria, then the New Test Stand criteria listed above in 1.a must be followed.

* Only test results from calibrated stands in the laboratory count towards the tally of three (3) required operationally valid calibration tests. The third test must complete (date and time) before the first test completes (date and time) on a New Test Stand that is seeking calibration with a single test result. In addition, the first test for the stand is to begin within twelve (12) months of the completion of the last acceptable calibration test. Also, there must not be any outstanding precision alarms for the laboratory.

23. Roller Follower Wear Test LTMS Requirements

The following are the specific Roller Follower Wear Test calibration requirements.

A. Reference Oils and Critical Parameter

The critical parameter is Average Roller Follower Shaft Wear. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the Roller Follower Wear Test Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameter are presented below.

AVERAGE ROLLER FOLLOWER SHAFT WEAR
Unit of Measure: mils

Reference Oil	Mean	Standard Deviation
1004-2	0.33	0.05
1004-3	0.44	0.06
1005-3	0.20	0.05
1005-4	0.20	0.05

B. Acceptance Criteria

1. New Test Stand

   - A minimum of two (2) operationally valid calibration tests with no stand Shewhart severity or precision alarms must be conducted on any approved reference oil.

   - All operationally valid calibration test results must be charted to determine if the test stand is currently "in control" as defined by the control charts from the Lubricant Test Monitoring System.

2. Existing Test Stand

   - The test stand must have previously been accepted into the system by meeting LTMS calibration requirements.

   - All operationally valid calibration test results on reference oils 1004 and 1005, or subsequent approved reblends, must be charted to determine if the test stand is currently "in control" as defined by the control charts from the Lubricant Test Monitoring System.

Sequence VG Reference Oil Targets														
Oil	n	Effective Dates		AES		RCS		AEV		APV		OSCRNSLG[7]		Hot Stuck Rings
		From[1]	To[2]	$\overline{X}$	S	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	Maximum Allowable
925-3	4	11-17-00	5-31-01	6.44	0.83	7.60	0.36	8.52	0.29	7.39	0.41	3.992	1.018	0
	10	6-1-01	11-02-04	6.23	0.62	7.38	0.45	8.57	0.24	7.40	0.28	4.147	0.649	0
	22	11-3-04	5-2-05	6.51	0.60	7.40	0.48	8.58	0.20	7.38	0.28	4.084	0.665	0
	26	5-3-05	7-28-11	6.49	0.55	7.43	0.44	8.56	0.20	7.38	0.26	3.997	0.669	0
	30	7-29-11	***	6.49	0.55	7.43	0.44	8.56	0.25[7]	7.38	0.36[7]	3.997	0.669	0
940[8]	5	11-14-12	9-24-13	6.43	0.51	8.15	0.44	8.79	0.25	7.20	0.63	3.951	0.840	0
	5	9-25-13	***	6.43	0.51	8.15	0.92	8.79	0.25	7.20	0.63	3.951	0.840	0
1006	18[4]	9-16-98	5-31-99	6.64	0.61[3]	8.23	0.56[3]	8.91	0.23[3]	7.72	0.32[3]	4.615	1.313[3]	0
	14[6]	6-1-99	11-15-99	8.11	0.68[5]	9.28	0.32[5]	9.25	0.10[5]	8.48	0.26[5]	1.680	0.645[5]	0
	10	11-16-99	5-24-00	8.35	0.72	9.34	0.26	9.27	0.12	8.56	0.20	1.412	0.828	0
	20	5-25-00	11-16-00	8.29	0.60	9.31	0.21	9.26	0.11	8.51	0.20	1.342	0.894	0
	29	11-17-00	***	8.43	0.60	9.35	0.20	9.27	0.10	8.49	0.18	1.384	0.850	0
1006-2	10	1-27-03	1-4-04	8.64	0.31	9.37	0.14	9.26	0.10	8.54	0.12	1.092	0.782	0
	20	1-5-04	11-02-04	8.69	0.42	9.41	0.16	9.25	0.11	8.54	0.13	0.918	0.649	0
	30	11-03-04	7-28-11	8.65	0.41	9.40	0.15	9.24	0.11	8.52	0.14	0.896	0.579	0
	30	7-29-11	9-24-13	8.65	0.41	9.40	0.15	9.24	0.12[7]	8.52	0.22[7]	0.896	0.579	0
	30	9-25-13	***	8.65	0.52	9.40	0.34	9.24	0.22	8.52	0.43	0.896	1.038	0
1007	18[4]	9-16-98	5-31-99	7.02	0.61[3]	7.72	0.56[3]	8.88	0.23[3]	7.83	0.32[3]	4.581	1.313[3]	0
	14[6]	6-1-99	11-15-99	9.16	0.68[5]	9.25	0.32[5]	9.28	0.10[5]	8.64	0.26[5]	0.462	0.645[5]	0
	10	11-16-99	11-16-00	8.94	0.28	9.06	0.30	9.24	0.09	8.59	0.13	0.801	0.667	0
	29	11-17-00	7-28-11	8.93	0.30	8.99	0.41	9.24	0.09	8.57	0.16	0.968	0.614	0
	30	7-29-11	***	8.93	0.30	8.99	0.41	9.24	0.11[7]	8.57	0.23[7]	0.968	0.614	0
1008	18[4]	9-16-98	8-13-99	9.00	0.61[3]	8.94	0.56[3]	9.16	0.23[3]	8.97	0.32[3]	0.660	1.313[3]	0

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Sequence VG Reference Oil Targets (continued)														
Oil	n	Effective Dates		AES		RCS		AEV		APV		OSCRNSLG[7]		Hot Stuck Rings
		From[1]	To[2]	$\overline{X}$	S	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	Maximum Allowable
1009	3	8-1-02	10-4-02	8.00	0.22	9.25	0.09	8.93	0.16	7.80	0.54	1.823	0.739	0
	5	10-5-02	5-14-03	7.78	0.36	9.15	0.22	8.93	0.11	7.84	0.40	2.670	1.303	0
	10	5-15-03	2-16-04	7.82	0.46	9.23	0.19	9.01	0.16	7.85	0.33	2.362	1.337	0
	20	2-17-04	11-02-04	7.87	0.43	9.29	0.19	9.00	0.15	7.80	0.29	2.274	1.044	0
	30	11-03-04	7-28-11	7.94	0.52	9.29	0.18	8.99	0.11	7.79	0.28	2.200	1.038	0
	30	7-29-11	9-24-13	7.94	0.52	9.29	0.18	8.99	0.22[7]	7.79	0.43[7]	2.200	1.038	0
	30	9-25-13	***	7.94	0.52	9.29	0.27	8.99	0.22[7]	7.79	0.43[7]	2.200	1.038	0

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Pooled s from GF-3 matrix analysis.
4 GF-3matrix n-size
5 Pooled s from fuel matrix analysis
6 Fuel matrix n-size
7 Updated AEV and APV standard deviations using last 30 tests, including fuel. approval results for oil 925-3, 1006-2, 1007 and 1009
8 See TMC Memo 12-033

1P Reference Oil Targets													
Oil	n	Effective Dates		TGC		TLC		AOC[1]		WDP		EOTOC[2]	
		From	To[3]	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s
1005	31	2-19-97	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-1[5]	--	6-6-98	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-2[5]	--	7-15-05	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-3[5]	--	12-30-09	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-4[5]	--	06-01-13	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1004-3	31	2-19-97	***	29.48	7.74	28.12	13.15	1.8321	0.3238	319.6	57.6	2.0492	0.5177
PC-7C[4]	31	2-19-97	***	42.63	7.74	42.03	13.15	2.8999	0.3238	390.2	57.6	3.4664	0.5177
PC-7D[4]	31	2-19-97	***	31.71	7.74	40.29	13.15	1.9572	0.3238	307.6	57.6	2.0719	0.5177
PC-7E[4]	31	2-19-97	***	32.53	7.74	37.52	13.15	1.9252	0.3238	341.9	57.6	2.5195	0.5177
PC-7F[4]	31	2-19-97	***	45.68	7.74	51.44	13.15	2.9930	0.3238	412.5	57.6	3.9367	0.5177
PC-7G[4]	31	2-19-97	***	25.49	7.74	29.87	13.15	1.8680	0.3238	279.7	57.6	1.5609	0.5177
PC-7H[4]	31	2-19-97	***	26.32	7.74	27.11	13.15	1.8360	0.3238	314.0	57.6	2.0084	0.5177
PC-7J[4]	31	2-19-97	***	39.46	7.74	41.02	13.15	2.9039	0.3238	384.6	57.6	3.4257	0.5177

1 Transformation for AOC is ln(AOC)
2 Transformation for EOTOC is ln(EOTOC)
3 *** = currently in effect
4 Oil used only for precision matrix
5 Targets based on 1005

1R Reference Oil Targets													
		Effective Dates		WDR		TGC		TLC		IOC		EOTOC	
Oil	n	From	To[1]	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s
820 (PC-9A)	7	7-1-01	12-31-01	341.2	36.2	34.11	10.28	22.82	10.50	8.3	1.7	7.9	2.6
820-2[2]	--	1-1-02	***	341.2	36.2	34.11	10.28	22.82	10.50	8.3	1.7	7.9	2.6
PC-9D[3]	2	7-1-01	***	285.9	6.5	28.13	3.01	13.75	8.84	10.0	2.3	10.2	1.3
1005-1	15	7-1-01	12-9-01	327.3	23.7	34.50	8.72	18.60	5.66	9.9	1.2	8.3	1.0
	20	12-10-01	***	327.9	23.1	34.51	8.70	18.61	6.00	10.0	1.1	8.3	1.0
1005-2	--	09-01-10	***	327.9	23.1	34.51	8.70	18.61	6.00	10.0	1.1	8.3	1.0
1005-3	--	09-01-10	***	327.9	23.1	34.51	8.70	18.61	6.00	10.0	1.1	8.3	1.0
1005-4	--	04-01-13	***	327.9	23.1	34.51	8.70	18.61	6.00	10.0	1.1	8.3	1.0

1 *** = currently in effect
2 Targets based on oil 820
3 Oil used only for precision matrix

Roller Follower Wear Test Reference Oil Targets						
Engine Type	Oil	n	Effective Dates		Average Wear	
			From[1]	To[2]	$\overline{X}$	s
6.2L	1004	15	5-27-93	5-31-96	0.40	0.08
	1004-1	--	2-1-94	10-16-94	0.40	0.08
		10	10-17-94	6-25-95	0.36	0.05
		21	6-26-95	5-31-96	0.35	0.04
	1004-2[3]	--	9-1-95	5-31-96	0.35	0.04
6.5L	1004-1	--	6-1-96	***	0.35	0.06[5]
	1004-2	--	6-1-96	12-31-97	0.35[4]	0.06[5]
		10	1-1-98	***	0.33	0.05
	1004-3	2	1-1-98	***	0.44	0.06
	1005	2	6-1-96	5-24-97	0.20	0.06
		4	5-25-97	8-11-97	0.19	0.06
		6	8-12-97	***	0.20	0.06
	1005-1[6]	--	5-1-98	10-31-00	0.20	0.06
		5	11-1-00	***	0.20	0.05[7]
	1005-2[8]	--	11-1-00	***	0.20	0.05
	1005-3[8]	--	08-20-10	***	0.20	0.05
	1005-4[8]	--	10-00-13	***	0.20	0.05

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Targets based on 1004-1.
4 Mean based on 1004-1.
5 Standard deviation based on all 6.2L results on all blends of 1004 through 5-31-96 (n=45).
6 Targets based on 1005.
7 Pooled standard deviation for all Roller Follower Wear reference oil tests through 10-12-00.
8 Targets based on 1005-1.

APPENDIX B

HISTORY OF INDUSTRY CORRECTION FACTORS
APPLICABLE TO LTMS DATA

Test Area	Effective	Description
IIIF	May 14, 2013	For reference oil tests completing on or after June 13, 2010, adjust the Hours to 275 % Viscosity Increase by adding 10 hours.
		For all non-reference tests refer to Section 12.7.9.6 of Test Method D6984
IIIG	None	None
IIIGA	None	None
IIIGB	July 24, 2009	Add 1.61 to PHOS
IVA	None	None
VG	July 1, 2005	For Fuel Batch TF2221LS20, Add 0.19 to AEV; Add 2.175 to AES and divide by 1.192 Add 0.54 to APV; Add 0.627 to RCS and divide by 1.041
	November 10, 2007	For Fuel Batch TF2221LS20, Add 0.12 to AEV; Add 0.42 to AES ; Add 0.39 to APV; Add 0.23 to RCS
	May 26, 2009	For Fuel Batch XC2721NX10, Add 3.011 to AEV and divide by 1.356; Add 1.325 to APV and divide by 1.207
	October 1, 2009	For Fuel Batch XC2721NX10, Subtract 0.24 from APV; subtract 0.12 from AEV.
	September 25, 2013	For Fuel Batch AK2821NX10-1, adjust AES by equation: $AES + e^{[(AES-5.00)(AES-9.70)]/351}$ Adjust RAC by equation: $(RAC - 4.71)/0.49$ Subtract 0.757 from transformed OSCR; Add 0.18 to AEV.
VIB	None	None
VID	None	None
VIII	None	None
1M-PC	None	None
1K	None	None
1N	May 1, 2004	Add -1.135 to ln(TLHC+1)
	September 28, 2005	Add -0.451 to ln(TLHC+1)
1P	None	None
1R	None	None
C13	None	None
ISB	April 21, 2011	For Batch B Tappets with Batch E, F, and G Cams; Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	December 11, 2011	For Batch C Tappets with Batch H Cams; Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	November 13, 2012	For Batch C Tappets with Batch H and J Cams; Multiply ATWL by 0.711; Add -5.6 to ACSW

APPENDIX B (continued)
HISTORY OF INDUSTRY CORRECTION FACTORS
APPLICABLE TO LTMS DATA

Test Area	Effective	Description
ISM	June 28, 2007	Add +1.7 to Crosshead Wear At 3.9% Soot Add +19.1 to Injector Adjusting Screw Wear At 3.9% Soot
	March 4, 2010	Add +1.3 to Crosshead Wear At 3.9% Soot
	April 30, 2011	Add +2.5 to Crosshead Wear At 3.9% Soot
T-8	September 17,2011	Add +0.40 to Viscosity Increase at 3.8% Soot
T-8E	September 17,2011	Add +0.08 to Relative Viscosity at 4.8% Soot (50% DIN Shear Loss) Add +0.09 to relative Viscosity at 4.8% Soot (100% DIN Shear Loss)
T-10A	None	None
T-11	September 14, 2005	Add -0.39% to Soot @ 12cSt Vis. Inc., Add 1274 cP to MRV Vis.
	December 6, 2005	Add -0.36% to Soot @ 12cSt Vis. Inc., Add 713 cP to MRV Vis.
	March 24, 2006	Add -0.35% to Soot @ 12cSt Vis. Inc., Add 956 cP to MRV Vis.
T-12	Batch R Piston Ring & Cylinder Liner Hardware	Multiply Average Cylinder Liner Wear by 0.58
	SWTN Hardware Completed On or Before May 18, 2011	Multiply Average Top Ring Weight Loss by 0.95
		Multiply Average Cylinder Liner Wear by 0.86
		$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.95)]
		$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 1.03)]
		OC = exp[(ln($OC_{100\text{-}300}$) x 0.96)]
	SWTN Hardware Completed On or After May 19, 2011	Multiply Average Top Ring Weight Loss by 0.92
		Multiply Average Cylinder Liner Wear by 0.83
		$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.92)]
		$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.93)]
		OC = exp[(ln($OC_{100\text{-}300}$) x 0.95)]
	SWTN Hardware Started On or After June 5, 2012	Multiply Average Top Ring Weight Loss by 0.705
		Multiply Average Cylinder Liner Wear by 0.946
		$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.923)]
		$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.956)]
		OC = exp[(ln($OC_{100\text{-}300}$) x 0.961)]
	UUXO Hardware	Multiply Average Top Ring Weight Loss by 0.849
		Multiply Average Cylinder Liner Wear by 0.566
		$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.797)]
		$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.700)]
		OC = exp[(ln($OC_{100\text{-}300}$) x 0.916)]
RFWT	None	None
EOAT	None	None

APPENDIX B (continued)
HISTORY OF INDUSTRY CORRECTION FACTORS
APPLICABLE TO LTMS DATA

Test Area				Description
L-33-1	None			None
L37	V1L686/P4L 626A	Lubrited Ring	Canadian	Ridging add 0.9922. Effective for any tests completing on or after June 12, 2001
	V1L686/P4L 626A	Lubrited Pinion & Ring	Canadian	Ridging add 0.6065. Effective for any tests completing on or after August 25, 2004
	L247/T758A	Lubrited Pinion	Canadian	Ridging add 0.5878, Pitting/Spalling add 0.7340
	V1L528	Nonlubrited Pinion	Standard	Ridging add 0.3365, Rippling add 0.3365
			Canadian	Rippling add 0.7885
		Lubrited Pinion	Standard	Ridging add 0.3365
			Canadian	Ridging add 0.5878, Rippling add 0.5878
		Lubrited Ring	Canadian	Ridging add 0.3365
L-42	None			None
L-60-1	None			None
HTCT	None			None
OSCT	None			None

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS

Test	Parameter	s	Effective Dates	
			From	To
Sequence VG	AES	0.61	19980916	19990531
		0.68	19990601	19991115
		0.55	19991116	20000524
		0.51	20000525	20001116
		0.47	20001117	20041231
		0.45	20050101	***
	RCS	0.56	19980916	19990531
		0.32	19990601	19991115
		0.28	19991116	20000524
		0.24	20000525	20001116
		0.33	20001117	20041231
		0.25	20050101	20130924
		0.56	20130925	***
	AEV	0.23	19980916	19990531
		0.10	19990601	19991115
		0.11	19991116	20000524
		0.10	20000525	20001116
		0.09	20001117	20041231
		0.10	20050101	20110728
		0.16	20110729	***
	APV	0.32	19980916	19990531
		0.26	19990601	19991115
		0.17	19991116	20000524
		0.18	20000525	20001116
		0.17	20001117	20041231
		0.20	20050101	20110728
		0.31	20110729	***
	OSCRNSLG	27.34	19980916	19990531
		18.10	19990601	19991115
		3.40	19991116	20000524
		0.828[1]	20000525	20001116
		0.742[1]	20001117	20041231
		0.793[1]	20050101	***

1 Transformation ln(OSCRNSLG + 1) adopted 20000525.