6. Sequence IVA LTMS Requirements

A. Reference Oils and Parameters

The critical parameter is Average Camshaft Wear. The reference oils required for stand calibration are the reference oils accepted by the ASTM Sequence IVA Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameter are presented below.

AVERAGE CAMSHAFT WEAR
Unit of Measure: micrometers

Reference Oil	Mean	Standard Deviation
1006-2	103.39	13.68
1007	84.76	15.40

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 (all parameters) and no stand Shewhart precision alarms (critical parameters only) on any approved reference oils.

   - 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 these 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.

- Exceed EWMA laboratory chart warning limit for precision

  – 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

  – 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

  – Conduct an additional calibration test.

- Exceed Shewhart laboratory chart limit for precision

  – 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:

    ACW (μm) $\qquad SA = (-Z_i) * (14.87)$

  – Confirm calculations with TMC.

- Exceed EWMA test stand chart limit for severity

  – Notify the TMC. If the direction of the test stand is deemed different from that of the laboratory, conduct an additional calibration test in the identified test stand. If this limit is still exceeded after the additional calibration test, then remove the test stand from the system, notify the TMC, correct test stand severity problem, and follow requirements for entry of a new test stand into the system.

- Exceed Shewhart test stand chart limit for severity

  – Conduct an additional calibration test.

Sequence IVA Reference Oil Targets					
Oil	n	Effective Dates		Average Camshaft Wear	
		From[1]	To[2]	$\overline{X}$	s
1006	24[4]	8-19-98	9-30-99	115.80	9.47[3]
	5[5]	10-1-99	1-25-00	117.14[5]	12.23[5]
	10	1-26-00	5-23-01	121.38	9.86
	77	5-24-01	***	121.76	12.50
1006-2	6	2-11-02	7-18-02	88.74	12.50[6]
	11	7-19-02	1-20-04	90.72	11.16
	22	1-21-04	2-01-12	91.15	8.93
	4	2-2-12	7-10-12	100.18	18.65
	15	7-11-12	***	103.39	13.68
1007	24[4]	8-19-98	9-30-99	95.58	9.47[3]
	11	5-24-01	12-31-02	92.12	16.76
	21	1-1-03	7-27-04	86.94	16.22
	31	7-28-04	***	84.76	15.40
1008	24[4]	8-19-98	9-30-99	40.16	9.47[3]
1009	5	12-18-02	4-30-04	21.03	6.23
	11	5-1-04	11-13-07	19.08	5.60
	29	11-14-07	6-1-11	18.76	7.05

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-3 matrix n-size
5 Individual oil 1006 statistics from prove-out matrix
6 Standard deviation based on oil 1006

APPENDIX C

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS

Test	Parameter	s	Effective Dates	
			From	To
Sequence IIIF	VIS80	0.0129546	20000610	***
	APV	0.220	20000610	***
	WPD	0.658	20000610	***
	VIS60	0.17334	20011115	***
Sequence IIIG	PVIS	0.2919	20030501	***
	WPD	0.60	20030501	***
	ACLW	0.1936	20030501	20040120
		0.1903	20040121	***
Sequence IIIGA	MRV Viscosity	0.30763	20031103	20040526
Sequence IIIGB	Phos. Retention	2.33	20081112	***
Sequence IVA	ACW	9.47	19980819	20010524
		12.50	20010525	20050630
		12.52	20050701	20120208
		15.72	20120209	20120710
		14.87	20120711	***

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

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)]
RFWT	None	None
EOAT	None	None
L-33-1	None	None
L-37	None	None
L-42	None	None
L-60-1	None	None
HTCT	None	None
OSCT	None	None