12. Sequence VIF LTMS Requirements

The following are the specific Sequence VIF calibration test requirements.

A. Reference Oils and Critical Parameters

The critical parameters are Fuel Economy Improvement at 16 hours (FEI1) and Fuel Economy Improvement at 109 hours (FEI2). The reference oils required for test stand/engine calibration are reference oils accepted by the ASTM Sequence VI Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

FUEL ECONOMY IMPROVEMENT at 16 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
1011	1.57	0.20
1011-1	1.57	0.20
543	1.78	0.34
543-1	1.78	0.34

FUEL ECONOMY IMPROVEMENT at 109 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
1011	1.46	0.28
1011-1	1.46	0.28
543	1.99	0.27
543-1	1.99	0.27

B. Reference Oil Assignment:

100% of the scheduled calibration tests shall be conducted on reference oils 543 and 1011 or subsequent approved reblends. If possible, the same oil should not be used for successive calibration tests in a stand. Where possible, oils should be run in the order of 543 first and 1011 next. In the case of a failed reference test, either oil may be used for the subsequent test.

C. Control Charts

In Section 1, the construction of the control charts that contribute to the Lubricant Test Monitoring System is outlined. For Sequence VIF, the following two statistics are used for calibration purposes at the stand/engine level for each parameter.

$$Average\ Y_i = W_i = \frac{Y_i + Y_{i-1} + Y_{i-2}}{n}$$

$$Repeatabilty\ Check = V_i = \frac{(Y_i - W_{i-1})}{R}$$

Where R = 1.00 for FEI1 and R = 0.95 for FEI2.

The calculation and calibration constants used for the construction of the control charts for the VIF, and the response necessary in the case of control chart limit alarms, are depicted below.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

Chart Level	Statistic	LAMBDA	Limit
Stand/Engine	Average Yi	N/A	±2.000
	Repeatability Check, FEI1	N/A	+4.46 -2.80
	Repeatability Check, FEI2	N/A	±2.80
Industry	Severity EWMA	0.2	±0.859

D. Acceptance Criteria

1. New Stand/Engine

a. A minimum of two operationally valid calibration test, with no acceptance limits exceeded (all parameters), is required to calibrate each stand/engine. Severity adjustments are only to be evaluated after an acceptable calibration test.

- Second operationally valid calibration test;

- If the repeatability check does not exceed the limit and the average Yi, does not exceed the limit, then calculate a stand/engine Severity Adjustment (SA) for each parameter as follows:

FEI1: $SA = (-W_i) \times (0.27)$
FEI2: $SA = (-W_i) \times (0.27)$

- If the repeatability check exceeds the limit or the average Yi exceeds the limit, then an additional calibration test is required in order to judge engine calibration. The laboratory has the option to remove the stand/engine.

- Third operationally valid calibration test;

  - If the repeatability check does not exceed the limit and the average Yi, does not exceed the limit, then calculate a stand/engine Severity Adjustment (SA) for each parameter as follows:

$$\text{FEI1: } SA = (-W_i) \times (0.27)$$
$$\text{FEI2: } SA = (-W_i) \times (0.27)$$

  - If the repeatability check exceeds the limit or the average Yi exceeds the limit, any additional testing on the stand/engine is not suitable for calibration purposes.

- Exceed EWMA Industry chart severity limit

  - TMC informs the surveillance panel that the limit has been exceeded. The surveillance panel then investigates and pursues resolution of the alarm.

3. Removal of Test Stand/Engines from the System

The laboratory must notify the TMC and the ACC Monitoring Agency when removing a stand/engine from the system. No reference oil data shall be removed from the control charts from test stand/engines that have been used for registered candidate oil testing. Reintroduction of a stand/engine into the system requires completion of new stand/engine acceptance requirements. In all instances of stand/engine removal, stand/engine renumbering can occur only if the stand/engine undergoes a significant rebuild, as agreed upon by the laboratory and the TMC.

13. Sequence VIII LTMS Requirements

The following are the specific Sequence VIII calibration test requirements. For purposes of the Sequence VIII, a test stand is defined as an engine/stand combination.

A. Reference Oils and Parameters

The critical parameter is Total Bearing Weight Loss (TBWL). The reference oils required for test stand and laboratory calibration are reference oils accepted by the ASTM Sequence VIII Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameter are presented below.

TOTAL BEARING WEIGHT LOSS
Unit of Measure: mg
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
704-1	8.3	2.32
1006	15.9	4.85
1006-2	17.5	4.23
1009-1	14.0	3.38

10-HOUR STRIPPED VISCOSITY
Unit of Measure: centistokes
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
704-1	10.27	0.11
1006	9.00	0.17
1006-2	9.37	0.07
1009-1	9.77	0.07

B. Acceptance Criteria

In addition to the calibration test requirements described below for new and existing test stands:

- A new bearing batch requires a minimum of two (2) operationally valid calibration tests with no stand Shewhart alarms per laboratory.

- Exceed EWMA laboratory chart action limit for severity (critical parameter only)

  – Calculate laboratory Severity Adjustment (SA) for TBWL, using the current laboratory EWMA (Z_i) as follows:

    TBWL: $SA = (-Z_i) \times (3.38)$

  – Confirm calculations with the TMC.

- Exceed EWMA test stand chart limit for severity (critical parameter only)

  – Notify the TMC. If the direction of the test stand severity is deemed different from that of the test laboratory, conduct an additional calibration test in the identified test stand. If this limit is still exceeded after the additional calibration test, then remove 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.

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

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

  – TMC to notify test sponsor, surveillance panel chairman, and ACC Monitoring Agency. Meeting of TMC, parts supplier, and surveillance panel required to determine course of action.

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

  – TMC to notify test sponsor, surveillance panel chairman, and ACC Monitoring Agency. Coordination of TMC, parts supplier, and surveillance panel chairman required to discuss potential problem.

Sequence VIF Reference Oil Targets							
Oil	n	Effective Dates		FEI1		FEI2	
		From[1]	To[2]	$\overline{X}$	s^3	$\overline{X}$	s^3
542-2[5]	6	11-22-15	12-6-24	2.23	0.18	1.52	0.13
542-3[4,5]	6	11-20-17	12-6-24	2.23	0.18	1.52	0.13
542-4[4,5]	6	09-20-19	12-6-24	2.23	0.18	1.52	0.13
542-5[4,5]	6	01-10-23	12-6-24	2.23	0.18	1.52	0.13
1011	5	11-22-15	12-5-24	1.45	0.14	1.41	0.39
1011	103	12-6-24	***	1.57	0.20	1.46	0.28
1011-1[4]	5	01-13-21	12-5-24	1.45	0.14	1.41	0.39
1011-1	50	12-6-24	***	1.57	0.20	1.46	0.28
543	7	11-22-15	12-5-24	1.88	0.27	2.25	0.34
543	131	12-6-24	***	1.78	0.34	1.99	0.27
543-1[4]	7	5-22-23	12-5-24	1.88	0.27	2.25	0.34
543-1	7	12-6-24	***	1.78	0.34	1.99	0.27

[1] Effective for all tests completed on or after this date.
[2] *** = currently in effect.
[3] Pooled s from precision matrix analysis.
[4] Targets from previous blend(s) used for this blend.
[5] Use of oil suspended by Panel effective 12/6/24

Sequence VIII Reference Oil Targets							
Oil	n	Effective Dates		TBWL		10 Hr. Stripped Viscosity	
		From[1]	To[2]	$\bar{X}$	s	$\bar{X}$	s
704-1	10[4]	8-29-98	11-16-99	7.9	3.40[3]	10.27	0.12[3]
	11	11-17-99	4-15-01	8.0	3.40	10.25	0.15
	23	4-16-01	12-16-01	8.3	2.44	10.29	0.11
	35	12-17-01	***	8.3	2.32	10.27	0.11
1006	10[4]	8-29-98	11-16-99	19.6	3.40[3]	9.09	0.12[3]
	10	11-17-99	4-15-01	17.1	5.28	9.00	0.22
	23	4-16-01	12-16-01	15.6	4.66	8.98	0.19
	32	12-17-01	***	15.9	4.85	9.00	0.17
1006-2	7	10-25-02	8-31-03	13.0	4.26	9.23	0.07
	12	9-1-03	5-14-04	12.4	2.59	9.24	0.06
	20	5-15-04	9-18-06	12.6	2.81	9.24	0.07
	--	9-19-06	3-11-07	15.9[5]	4.85[5]	9.24	0.07
	11	3-12-07	***	17.5	4.23	9.37	0.07
1009	5	1-7-03	1-23-05	12.8	2.00	9.51	0.10
	11	1-24-05	5-21-21	13.8	2.14	9.51	0.10
1009-1	4	10-5-23	12-2-24	16.2	3.48	9.73	0.07
1009-1	14	12-3-24	***	14.0	3.38	9.77	0.07

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 Targets based on oil 1006.

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS (Continued)

Test	Parameter	s	Effective Dates	
			From	To
Sequence IX	AVPIE	0.2856	20170421	20190627
	AVPIE	0.3775	20190628	***
Sequence X	CHST	0.17856	20170101	***
Sequence VIE	FEI1	0.29	20151213	20180313
	FEI2	0.25	20151213	20180313
	FEI1	0.235	20180314	***
	FEI2	0.281	20180314	***
Sequence VIF	FEI1	0.22	20151122	20241205
	FEI2	0.30	20151122	20241205
	FEI1	0.27	20241206	***
	FEI2	0.27	20241206	***
Sequence VIII	TBWL	3.40	19980829	19991116
		5.28	19991117	20020205
		4.80	20020206	20231202
		3.38	20241203	***
	10hr. Stripped Vis.	None	--	--
1M-PC	WTD	50.5	19930914	***
	TGF	16.1	19930914	***
1K	WDK	35.6	19900506	***
	TGF	15.7	19900506	***
	TLHC	1.1	19900506	***
	OC	None	--	--
1N	WDN	27.1	19930314	***
	TGF[1]	14.6	19930314	20150331
		0.488165	20150401	***
	TLHC	0.9	19930314	***
	OC	None	--	--
1P	TGC	7.740	19970219	***
	TLC	13.150	19970219	***
	AOC	0.3238	19970219	***
	WDP	57.60	19970219	***
	EOTOC	0.5177	19970219	***
1R	WDR	29.0	20010701	***
	TGC	9.70	20010701	***
	TLC	7.84	20010701	***
	IOC	1.32	20010701	***
	EOTOC	1.35	20010701	***
C13	TGC	None	--	--
	TLC	None	--	--
	OCΔ	None	--	--
	R2TC	None	--	--

[1] Transformation ln(TGF+1) adopted 20150401

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS (Continued)

Test	Parameter	s	Effective Dates	
			From	To
C13 Aeration	AAVE4050	0.285	20141101	20180201
		0.2774	20180202	***
ISB	Camshaft Wear	8.7	20171129	20200903
		8.5	20200904	***
	Tappet Wt. Loss	14.8	20171129	***
ISM	X-Head Wear	None	--	--
	OFDP	None	--	--
	Average Sludge	None	--	--
	Adj. Screw Wear	None	--	--
T-8	Vis. Inc. @ 3.8%	1.19	19940401	19960930
		0.93	19961001	19990131
		0.90	19990201	20070524
		0.00	20070525	20110916
		0.56	20110917	***
T-8E	Rel. Vis. @ 4.8% 50% DIN Shear	0.26	19970127	20070524
		0.00	20070525	20110916
		0.08	20110917	***
	Rel. Vis. @ 4.8% 100% DIN Shear	0.27	20020306	20070524
		0.00	20070525	20110916
		0.09	20110917	***
T-11	Soot@4.0 cSt Vis	0.23	20050528	20130702
	Soot@12.0 cSt Vis	0.21	20030308	20130702
	Soot@15.0 cSt Vis	0.26	20050528	20130702
	MRV Viscosity	1097	20030308	20130702
	Soot@4.0 cSt Vis	0.20	20130703	***
	Soot@12.0 cSt Vis	0.50	20130703	***
	Soot@15.0 cSt Vis	0.61	20130703	***
	MRV Viscosity	584	20130703	20200729
	MRV Viscosity	1117	20200730	***