2. Sequence IIIF LTMS Requirements

The following are the specific Sequence IIIF calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Hours to 275% Viscosity Increase, Average Piston Varnish, Weighted Piston Deposits. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Sequence IIIF Surveillance Panel. The means and standard deviations for the current reference oils for each critical and noncritical parameter are presented below.

HOURS to 275% VISCOSITY INCREASE
Unit of Measure: Hours
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
433-1	121.09	7.701

AVERAGE PISTON VARNISH
Unit of Measure: Merits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
433-1	9.30	0.300

WEIGHTED PISTON DEPOSITS
Unit of Measure: Merits
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
433-1	4.59	0.697

PERCENT VISCOSITY INCREASE @ 80 HOURS
Unit of Measure: 1/SQRT(VIS80)
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
433-1	0.1635099	0.0302263

21. T-11 LTMS Requirements

The following are the specific T-11 calibration test requirements.

A. Reference Oils and Parameters

The critical parameter is Soot at 12.0 cSt Viscosity Increase. Soot at 4.0 cSt Viscosity Increase, Soot at 15.0 cSt Viscosity Increase, and MRV Viscosity are noncritical parameters. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Mack Test Surveillance Panel. The mean and standard deviation for the current reference oils for critical and noncritical parameters are presented below.

SOOT @ 4.0 cSt VISCOSITY INCREASE
Unit of Measure: %
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-3	3.95	0.30
822-1	4.09	0.20
822-2	4.09	0.20

SOOT @ 12.0 cSt VISCOSITY INCREASE
Unit of Measure: %
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-3	5.92	0.22
822-1	5.81	0.50
822-2	5.81	0.50

SOOT @ 15.0 cSt VISCOSITY INCREASE
Unit of Measure: %
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-3	6.51	0.20
822-1	6.48	0.61
822-2	6.48	0.61

MRV VISCOSITY
Unit of Measure: cP
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
820-3	14981	916
822-1	13948	584
822-2	13948	584

B. Acceptance Criteria

1. New Test Stand

a. Less than four (4) Operationally Valid Calibration Results in Laboratory

- A minimum of two (2) operationally valid calibration tests with no stand Shewhart severity 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.

b. Four (4) 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 alarms 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 toward the tally of four (4) required operationally valid calibration tests. The fourth 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.

c. Stand for which a lapse in calibration is not greater than two years.

- The first operationally valid calibration test run on any approved reference oil must have no stand Shewhart severity 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.

2. Existing Test Stand

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

- All operationally valid calibration tests 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:

- 100% of the scheduled calibration tests should be conducted on reference oil 820-3, 822-1 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 of the control charts for the T-11, and the response necessary in the case of control chart limit alarms, are depicted below.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Reduced	--	--	--	--	--	1.43
	Action	0.3	0.3	1.74	2.05	1.74	1.75
Lab	Warning	0.2	--	1.74	--	--	--
	Action	0.2	0.2	2.58	1.96	1.74	1.75
Industry	Warning	0.2	0.2	1.74	2.05	--	--
	Action	0.2	0.2	2.58	2.81	--	--

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 EWMA laboratory chart action limit for precision (critical parameter only)
  - Immediately provide written notice of the alarm and its meaning to all Test Purchasers and the TMC. This notice shall be appended to all test reports during the alarm period.
- Exceed EWMA laboratory chart warning limit for precision (critical parameter only)
  - Immediately provide written notice of the alarm and its meaning to all Test Purchasers and the TMC. This notice shall be appended to all test reports during the alarm period.

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

  – Immediately provide written notice of the alarm and its meaning to all Test Purchasers and the TMC. This notice shall be appended to all test reports for the stand in question during the alarm period.

- Exceed Shewhart test stand chart limit for precision (critical parameter only)

  – Immediately provide written notice of the alarm and its meaning to all Test Purchasers and the TMC. This notice shall be appended to all test reports for the stand in question during the alarm period.

- Exceed EWMA laboratory chart action limit for severity (all parameters)

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

Soot at 4.0 cSt Viscosity Increase:	SA = ($-Z_i$) x (0.20)
Soot at 12.0 cSt Viscosity Increase:	SA = ($-Z_i$) x (0.50)
Soot at 15.0 cSt Viscosity Increase:	SA = ($-Z_i$) x (0.61)
MRV Viscosity:	SA = ($-Z_i$) x (584)

  – Confirm calculation 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 (critical parameter 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

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

- Exceed EWMA industry chart warning limit

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

T-11 Reference Oil Targets											
		Effective Dates		Soot @ 4.0 cSt Vis. Inc		Soot @ 12.0 cSt Vis. Inc		Soot @ 15.0 cSt Vis. Inc.		MRV Viscosity	
Oil	n	From	To[1]	$\bar{X}$	S	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
820-2	32	3-8-03	***	--	--	5.78	0.21	--	--	14969	1097
820-2	16	5-28-05	5-31-10	3.81	0.23	5.78[2]	0.21[2]	6.36	0.26	14969[2]	1097[2]
	--[3]	6-1-10	***	3.95	0.30	5.92	0.22	6.51	0.20	14981	916
820-3	11	9-7-07	***	3.95	0.30	5.92	0.22	6.51	0.20	14981	916
822-1	4	2-1-2013	7-2-2013	3.99	0.21	5.65	0.54	6.35	0.66	14408	314
	8	7-3-2013	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584
822-2	8	1-1-2014	***	4.09	0.20	5.81	0.50	6.48	0.61	13948	584

1 *** = currently in effect
2 Value based on earlier data set (n=32)
3 Targets based on oil 820-3

APPENDIX B

HISTORY OF INDUSTRY CORRECTION FACTORS

Test Area	Effective		Condition	Correction
	From	To		
IIIF	June 13, 2010	***	Reference Tests	Adjust the Hours to 275 % Viscosity Increase by adding 10 hours.
			Non-reference Tests	Refer to Section 12.7.9.6 of Test Method D6984
IIIG	None		All Tests	None
IIIGA	None		All Tests	None
IIIGB	July 24, 2009	***	All Tests	Add 1.61 to PHOS
IVA	None		All Tests	None
VG	July 1, 2005	November 9, 2007	All tests using 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	***	All tests using 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	September 30, 2009	All tests using 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	***	All tests using fuel batch XC2721NX10	Subtract 0.24 from APV
				Subtract 0.12 from AEV
	September 25, 2013	***	All tests using 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		All Tests	None
VID	None		All Tests	None
VIII	None		All Tests	None

HISTORY OF INDUSTRY CORRECTION FACTORS

Test Area	Effective From	Effective To	Condition	Description
1M-PC	None		All Tests	None
1K	None		All Tests	None
1N	May 1, 2004	September 27, 2005	All Tests	Add -1.135 to ln(TLHC+1)
	September 28, 2005	***	All Tests	Add -0.451 to ln(TLHC+1)
1P	None		All Tests	None
1R	None		All Tests	None
C13	None		All Tests	None
ISB	April 21, 2011	***	All tests using batch B tappets with batch E, F, and G cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	December 11, 2011	November 12, 2012	All tests using batch C Tappets with batch H cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	November 13, 2012	***	All tests using batch C tappets with batch H and J cams	Multiply ATWL by 0.711; Add -5.6 to ACSW
ISM	June 28, 2007	***	All Tests	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	***	All Tests	Add +1.3 to Crosshead Wear At 3.9% Soot
	April 30, 2011	***	All Tests	Add +2.5 to Crosshead Wear At 3.9% Soot
	November 19, 2013	***	All Tests	Add -0.200 to ln(SAIAS)
T-8	September 17, 2011	***	All Tests	Add +0.40 to Viscosity Increase at 3.8% Soot
T-8E	September 17,2011	***	All Tests	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		All Tests	None

APPENDIX B (continued)
HISTORY OF INDUSTRY CORRECTION FACTORS

Test Area	Effective		Condition	Description
	From	To		
T-11	September 14, 2005	***	All Tests	Add -0.39% to Soot @ 12cSt Vis. Inc., Add 1274 cP to MRV Vis
	December 6, 2005	***	All Tests	Add -0.36% to Soot @ 12cSt Vis. Inc., Add 713 cP to MRV Vis.
	March 24, 2006	***	All Tests	Add -0.35% to Soot @ 12cSt Vis. Inc., Add 956 cP to MRV Vis.
T-12	***	***	All tests using batch R piston ring & cylinder liner hardware	Multiply Average Cylinder Liner Wear by 0.58
	***	May 18, 2011	All Tests SWTN Hardware	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)]
				ΔLead $(250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 1.03)]
	May 19, 2011	June 4, 2012	All tests using SWTN Hardware	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)]
				ΔLead $(250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.93)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.95)]
				Multiply Average Top Ring Weight Loss by 0.92
	June 5, 2012	***	All tests using SWTN Hardware	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)]
				ΔLead $(250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.956)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.961)]
	***	***	All tests using 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)]
				ΔLead $(250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.700)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.916)]
	***	***	All tests using VUXO 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)]
				ΔLead $(250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.700)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.916)]
RFWT	None		All Tests	None
EOAT	None		All Tests	None

Test Area	Effective From	Effective To	Condition			Description
L-33-1			None			None
L37	20010612	***	V1L686/P4L626A Non-reference	Lubrited Ring	Canadian	Ridging add 0.9922
	20040825	***	V1L686/P4L626A Non-reference	Lubrited Pinion & Ring	Canadian	Ridging add 0.6065
	***	***	L247/T758A Non-reference	Lubrited Pinion	Canadian	Ridging add 0.5878, Pitting/Spalling add 0.7340
	***	20130514	V1L528/P4T883A Non-reference	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
	20130515	***	V1L528/P4T883A Non-reference	Nonlubrited Pinion	Standard	Ridging add 0.3365, Rippling add 0.3365
					Canadian	Rippling add 0.7566
				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