19. T-8 / T-8E LTMS Requirements

The following are the specific T-8 and T-8E calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Viscosity Increase at 3.8% Soot (T-8 and T-8E) and Relative Viscosity at 4.8% Soot, 50% DIN Shear Loss (T-8E only). Relative Viscosity at 4.8% Soot, 100% DIN Shear Loss is a non-critical parameter (T-8E only). 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 each critical and non-critical parameter are presented below.

VISCOSITY INCREASE @ 3.8% SOOT
Unit of Measure: cSt
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-3	5.01	0.56
1005-4	5.01	0.56

RELATIVE VISCOSITY @ 4.8% SOOT
50% DIN Shear Loss
Unit of Measure: unitless
CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-3	1.76	0.08
1005-4	1.76	0.08

RELATIVE VISCOSITY @ 4.8% SOOT
100% DIN Shear Loss
Unit of Measure: unitless
NON-CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-3	2.00	0.09
1005-4	2.00	0.09

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.

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
822-1	4.09	0.20

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

Reference Oil	Mean	Standard Deviation
822-1	5.81	0.50

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

Reference Oil	Mean	Standard Deviation
822-1	6.48	0.61

MRV VISCOSITY
Unit of Measure: cP
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
822-1	13948	584

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

  – 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.

24. Engine Oil Aeration Test LTMS Requirements

The following are the specific Engine Oil Aeration Test calibration requirements.

A. Reference Oils and Critical Parameter

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

AVERAGE ENGINE OIL AERATION
Unit of Measure: %

Reference Oil	Mean	Standard Deviation
1005-3	7.80	0.25
1005-4	7.80	0.25

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.

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 1004 and 1005 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 Engine Oil Aeration Test, 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	Warning	0.30	0.30	1.65	--	--	--
	Action	0.30	0.30	2.33	0.00	1.46	1.75
Industry	Warning	0.15	0.15	1.98	2.35	--	--
	Action	0.15	0.15	2.80	3.10	--	--

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 test stand chart action 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 EWMA test stand chart warning limit for precision
  - Immediately begin two consecutive calibration tests on the stand which exceeded the warning limit. Notify the TMC.
- Exceed Shewhart test stand chart action limit for precision
  - Conduct an additional calibration test.
- Exceed EWMA stand chart action limit for severity
  - Calculate stand Severity Adjustment (SA) for Average Engine Oil Aeration, using the current stand EWMA (Z_i) as follows:

    Average Engine Oil Aeration: SA = $(-Z_i) \times (0.25)$
  - Confirm calculation with the TMC.

T-8 Reference Oil Targets					
		Effective Dates		Viscosity Increase @ 3.8% Soot	
Oil	n	From[1]	To[2]	$\overline{X}$	s
1004-1	30	4-1-94	***	5.13	1.19
1004-2	10	7-1-95	10-31-95	4.49	1.19[3]
	20	11-1-95	1-31-96	4.46	1.19[3]
	30	2-1-96	9-30-96	4.46	1.19[3]
	59	10-1-96	***	4.92	0.93
1004-3	--	11-15-97	4-30-98	4.92[4]	0.93[4]
	10	5-1-98	9-13-98	4.71	0.97
	22	9-14-98	1-31-99	4.57	0.95
	30	2-1-99	***	4.57	0.90
1005-2	5	5-24-07	1-24-08	5.85[5]	0.72[5]
	3	1-25-08	2-6-08	4.83	0.72[5]
	5	2-7-08	***	5.11	0.66
1005-3[6]	--	08-12-10	9-16-11	5.11	0.66
	--	9-17-11	***	5.01[7]	0.56[7]
1005-4[7]	--	09-21-12	***	5.01[7]	0.56[7]

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Standard deviation based on 1004-1.
4 Targets based on 1004-2.
5 Targets based on previous tests on 1005.
6 Targets based on 1005-2.
7 Targets based on all blends of 1005.

T-8E Reference Oil Targets							
		Effective Dates		Relative Viscosity @ 4.8% Soot 50% DIN Shear Loss		Relative Viscosity @ 4.8% Soot 100% DIN Shear Loss	
Oil	n	From[1]	To[2]	$\overline{X}$	s	$\overline{X}$	s
1004-2	24	1-27-97	***	2.02	0.26	--	--
1004-3	--	11-15-97	4-30-98	2.02[3]	0.26[3]	--	--
	10	5-1-98	9-13-98	2.10	0.29	--	--
	21	9-14-98	1-31-99	2.09	0.27	--	--
	30	2-1-99	***	2.07	0.26	--	--
	59	2-1-98	***	--	--	2.21	0.27
1005-2	5	5-24-07	1-24-08	2.09[4]	0.15[4]	2.42[4]	0.16[4]
	3	1-25-08	2-6-08	1.74	0.15[4]	1.98	0.16[4]
	5	2-7-08	***	1.78	0.11	2.03	0.12
1005-3[5]	--	08-12-10	9-16-11	1.78	0.11	2.03	0.12
	--	9-17-11	***	1.76[6]	0.08[6]	2.00[6]	0.09[6]
1005-4[6]	--	09-21-12	***	1.76[6]	0.08[6]	2.00[6]	0.09[6]

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Targets based on 1004-2.
4 Targets based on previous tests on 1005.
5 Targets based on 1005-2
6 Targets based on all blends of 1005.

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]	$\overline{X}$	S	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	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

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

Engine Oil Aeration Test Reference Oil Targets					
		Effective Dates		Average Engine Oil Aeration	
Oil	n	From[1]	To[2]	$\overline{X}$	s
1004-2	13	6-2-95	***	9.46	0.25
1004-3	--	10-25-97	***	9.46[3]	0.25[4]
1005	2	5-10-97	***	7.80	0.25[4]
1005-1	--	8-12-98	***	7.80[5]	0.25[4]
1005-2[6]	--	09-30-05	***	7.80[5]	0.25[4]
1005-3[6]	--	01-01-11	***	7.80[5]	0.25[4]
1005-4[6]	--	01-01-13	***	7.80[5]	0.25[4]

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Mean based on 1004-2.
4 Standard deviation based on 1004-2.
5 Mean based on 1005.
6 Targets based on 1005-1

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

Test Area	Effective			Description
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
L-33-1	None			None
L-37	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

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

Test Area	Effective	Description
L-42	None	None
L-60-1	None	None
HTCT	None	None
OSCT	None	None

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

Test	Parameter	s	Effective Dates	
			From	To
T-8	Vis. Inc. @ 3.8%	1.19	19940401	19960930
	Vis. Inc. @ 3.8%	0.93	19961001	19990131
	Vis. Inc. @ 3.8%	0.90	19990201	20070524
	Vis. Inc. @ 3.8%	0.00	20070525	20110916
	Vis. Inc. @ 3.8%	0.56	20110917	***
T-8E	Rel. Vis. @ 4.8% 50% DIN Shear	0.26	19970127	20070524
	Rel. Vis. @ 4.8% 50% DIN Shear	0.00	20070525	20110916
	Rel. Vis. @ 4.8% 50% DIN Shear	0.08	20110917	***
	Rel. Vis. @ 4.8% 100% DIN Shear	0.27	20020306	20070524
	Rel. Vis. @ 4.8% 100% DIN Shear	0.00	20070525	20110916
	Rel. Vis. @ 4.8% 100% DIN Shear	0.09	20110917	***
T-10A	MRV Viscosity	511	20001201	20020115
		643	20020116	20020924
		496	20020925	20030121
		497	20030122	***
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	***
T-12	Cyl. Liner Wear	1.6	20050219	***
	Top Ring Wt. Loss	24.9	20050219	***
	Oil Consumption	0.0610	20050219	***
	ΔPB @ EOT	0.2880	20050219	***
	ΔPB 250-300 h	0.3630	20050219	***
	Cyl. Liner Wear	1.6	20050219	***
	Top Ring Wt. Loss	24.9	20050219	***
	Oil Consumption	0.0610	20050219	***
	ΔPB @ EOT	0.2880	20050219	***
	ΔPB 250-300 h	0.3630	20050219	***
RFWT	Ave. Wear	0.08	19930527	19941016
	Ave. Wear	0.05	19941017	19950625
	Ave. Wear	0.04	19950626	***
EOAT	Average Aeration	0.25	19990101	***
T-12A	MRV Viscosity	331	20100216	***

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

Test	Parameter	s	Effective Dates	
			From	To
L-33-1	Rust	0.350	20020611	***
L-37 Nonlubrited	Pinion Ridging	0.666	19000101	***
	Pinion Rippling	0.557	19000101	***
	Pinion Spitting	0.847	19000101	***
	Pinion Wear	0.713	19000101	***
L-37 Lubrited	Pinion Ridging	1.430	19000101	***
	Pinion Rippling	0.476	19000101	***
	Pinion Spitting	0.579	19000101	***
	Pinion Wear	0.519	19000101	***
L-42	% Scoring	None	--	--
L-60-1	Vis. Inc.	0.15	19940603	20050420
		0.08	20050421	***
	Pentane	0.73	19940603	20050420
		0.20	20050421	***
	Carbon/Varnish	0.45	19940603	20050420
		0.44	20050421	***
	Sludge	0.16	19940603	***
	Toluene	0.75	19940603	20050420
		0.34	20050421	***
HTCT	Cycles	None	--	--
OSCT	Elongation	None	--	--
	Shore Hardness	None	--	--
	Volume Change	None	--	--