

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

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

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

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.

- Exceed EWMA test stand chart limit for precision (critical parameters 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 parameters 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 laboratory chart action limit for precision (critical parameters 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 action limit for severity (all parameters)
 - Calculate laboratory Severity Adjustment (SA) using the current laboratory EWMA (Z_i) as follows:

Viscosity Increase at 3.8% Soot:	$SA = (-Z_i) \times (0.56)^*$
Relative Viscosity at 4.8% Soot, 50% DIN Shear Loss:	$SA = (-Z_i) \times (0.08)^*$
Relative Viscosity at 4.8% Soot, 100% DIN Shear Loss:	$SA = (-Z_i) \times (0.09)^*$

* s based on reference oil 1005 and reblends
 - Confirm calculations with the TMC.
- Exceed EWMA test stand chart limit for severity (critical parameters 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 parameters only)
 - Conduct an additional calibration test.

22. T-12 LTMS Requirements

The following are the specific T-12 calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Cylinder Liner Wear, Top Ring Weight Loss, Oil Consumption, and ΔPb at End of Test. The noncritical parameter is ΔPb 250–300 hours. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Mack Test Surveillance Panel. The means and standard deviations for the current reference oils for each critical and noncritical parameter are presented below.

CYLINDER LINER WEAR
Unit of Measure: Micrometres
CRITICAL PARAMETER
NORMAL K VALUE

Reference Oil	Level	Mean	Standard Deviation
821	Stand	16.2	3.7
821	Lab	15.1	2.8
821-1	Stand	16.2	3.7
821-1	Lab	15.1	2.8
821-2	Stand	16.2	3.7
821-2	Lab	15.1	2.8

TOP RING WEIGHT LOSS
Unit of Measure: Milligrams
CRITICAL PARAMETER
EXPANDED K VALUE

Reference Oil	Mean	Standard Deviation
821	62.0	28.2
821-1	62.0	28.2
821-2	62.0	28.2

OIL CONSUMPTION
Unit of Measure: LN(OC grams/hour)
CRITICAL PARAMETER
EXPANDED K VALUE

Reference Oil	Mean	Standard Deviation
821	4.0930	0.0790
821-1	4.0930	0.0790
821-2	4.0930	0.0790

Δ PB AT END OF TEST
 Unit of Measure: LN(Δ Pb ppm)
 CRITICAL PARAMETER
 NORMAL K VALUE

Reference Oil	Mean	Standard Deviation
821	3.1060	0.2420
821-1	3.1060	0.2420
821-2	3.1060	0.2420

Δ PB 250 – 300 HOURS
 Unit of Measure: LN(Δ Pb 250-300 ppm)
 NONCRITICAL PARAMETER
 NORMAL K VALUE

Reference Oil	Mean	Standard Deviation
821	2.1250	0.3330
821-1	2.1250	0.3330
821-2	2.1250	0.3330

B. Acceptance Criteria

1. New Test Stand

a. First Test Stand in a Laboratory

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

b. All Subsequent New Test Stands in a Laboratory

- One operationally valid test with no stand Shewhart severity alarms (critical parameters only) must be conducted on any approved reference oil.

2. Existing Test Stand

- The test stand must have been previously 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:

- 100% of the scheduled calibration tests should be conducted on reference oil 821 or subsequent approved reblends.

4. Control Charts

In Section 1 of the LTMS, 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-12, 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	Parameters	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Normal	Action	0.3	0.3	2.10	2.36	2.10	1.80
	Expanded K	Action	0.3	0.3	2.10	2.36	2.10	2.40
Lab	All	Warning	0.3	--	2.10	--	--	--
	Normal	Action	0.3	0.2	2.80	1.96	2.10	1.80
	Expanded K	Action	0.3	0.2	2.80	1.96	2.10	2.40
Industry	All	Warning	0.2	0.2	2.10	2.36	--	--
	All	Action	0.2	0.2	2.80	3.00	--	--

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 EWMA laboratory chart action limit for precision (critical parameters 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 parameters 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 parameters 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 parameters 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 laboratory chart action limit for precision (critical parameters 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 action limit for severity (all parameters)
 - Calculate laboratory Severity Adjustment (SA) for each parameter that exceeds action limit, using the current laboratory EWMA (Z_i) as follows:

Cylinder Liner Wear:	$SA = (-Z_i) \times (1.6)$
Top Ring Weight Loss:	$SA = (-Z_i) \times (24.9)$
Oil Consumption:	$SA = (-Z_i) \times (0.0610)$
ΔPb at End of Test:	$SA = (-Z_i) \times (0.2880)$
ΔPb 250 - 300 Hours:	$SA = (-Z_i) \times (0.3630)$
 - Confirm calculations with the TMC.
- Exceed EWMA test stand chart limit for severity (critical parameters 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 parameters only)
 - Conduct an additional calibration test.

T-8 Reference Oil Targets					
Oil	n	Effective Dates		Viscosity Increase @ 3.8% Soot	
		From ¹	To ²	\bar{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

- 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							
Oil	n	Effective Dates		Relative Viscosity @ 4.8% Soot 50% DIN Shear Loss		Relative Viscosity @ 4.8% Soot 100% DIN Shear Loss	
		From ¹	To ²	\bar{X}	s	\bar{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

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-12 Reference Oil Targets														
Oil	Level	n	Effective Dates		Cylinder Liner Wear		Top Ring Weight Loss		Oil Consumption		ΔPB @ End of Test		ΔPB 250-300 Hours	
			From	To ¹	\bar{X}	s	\bar{X}	s	\bar{X}	s	\bar{X}	s	\bar{X}	s
820-2	Stand	4	2-19-05	3-20-05	23.2	4.5	102.0	15.0	4.2770	0.0950	3.0269	0.2034	2.1647	0.1074
820-2	Lab	4	2-19-05	3-20-05	23.2	4.5	102.0	15.0	4.2770	0.0950	3.0269	0.2034	2.1647	0.1074
820-2	Stand	8	6-13-05	12-31-05	18.2	3.5	54.6	24.9	4.2040	0.0610	2.9250	0.2880	2.0020	0.3630
820-2	Lab	8	6-13-05	12-31-05	19.2	1.6	54.6	24.9	4.2040	0.0610	2.9250	0.2880	2.0020	0.3630
831 (PC10B)	Stand	5	6-13-05	12-31-05	12.8	3.2	54.5	24.9	4.1240	0.0610	3.3770	0.2880	2.2450	0.3630
831 (PC10B)	Lab	5	6-13-05	12-31-05	12.5	1.6	54.5	24.9	4.1240	0.0610	3.3770	0.2880	2.2450	0.3630
821 (PC10E)	Stand	6	6-13-05	3-12-08	15.1	3.4	66.4	24.9	4.0830	0.0610	3.2590	0.2880	2.2510	0.3630
821 (PC10E)	Stand	25	3-13-08	***	16.2	3.7	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330
821 (PC10E)	Lab	6	6-13-05	3-12-08	14.6	1.6	66.4	24.9	4.0830	0.0610	3.2590	0.2880	2.2510	0.3630
821 (PC10E)	Lab	25	3-13-08	***	15.1	2.8	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330
821-1 ²	Stand	--	3-13-08	***	16.2	3.7	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330
821-1 ²	Lab	--	3-13-08	***	15.1	2.8	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330
821-2 ³	Stand	--	9-27-11	***	16.2	3.7	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330
821-2 ³	Lab	--	9-27-11	***	15.1	2.8	62.0	28.2	4.0930	0.0790	3.1060	0.2420	2.1250	0.3330

- 1 *** = currently in effect
- 2 Targets based on oil 821
- 3 Targets based on 25 tests on 821

APPENDIX B
HISTORY OF INDUSTRY CORRECTION FACTORS
APPLICABLE TO LTMS DATA

Test Area	Effective	Description
IIIF	None	None
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.
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)
1P	None	None
1R	None	None
C13	None	None
ISB	None	None
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
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.

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	***
	Soot@12.0 cSt Vis	0.21	20030308	***
	Soot@15.0 cSt Vis	0.26	20050528	***
	MRV Viscosity	1097	20030308	***
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	***
RFTW	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	***
L-33-1	Rust	0.350	20020611	***

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

Test	Parameter	s	Effective Dates	
			From	To
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	--	--