27. 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 parameter is Relative Viscosity at 4.8% Soot, 100% DIN Shear Loss (T-8E only). Viscosity Increase at 3.8% Soot and Relative Viscosity at 4.8% Soot, 50% DIN Shear Loss are non-critical parameters (T-8 and T-8E). 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
NON-CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-3	5.01	0.56
1005-4	5.01	0.56
1005-5	5.01	0.56

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

Reference Oil	Mean	Standard Deviation
1005-3	1.76	0.08
1005-4	1.76	0.08
1005-5	1.76	0.08

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

Reference Oil	Mean	Standard Deviation
1005-3	2.00	0.09
1005-4	2.00	0.09
1005-5	2.00	0.09

B. Acceptance Criteria

1. New Test Stand

- A minimum of two (2) operationally valid calibration tests with no stand Level 3 e_i or Level 2 Z_i alarms after the second operationally valid test must be conducted on any approved reference oil.

- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

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.
- One operationally valid test with no level 3 e_i or level 2 Z_i alarms must be conducted on any approved reference oil.
- Following the necessary tests, check the status of the control charts and follow the prescribed actions.
- For Viscosity Increase @ 3.8% Soot, results of all operationally valid calibration tests starting on or after April 1, 1994 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.
- For Relative Viscosity @ 4.8% Soot, 50% DIN Shear Loss, results of all operationally valid 300 hour calibration tests starting on or after January 14, 1997 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.
- For Relative Viscosity @ 4.8% Soot, 100% DIN Shear Loss, results of all operationally valid 300 hour 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 1005-2 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. For the T8 and T-8E, Z_0=mean Y_i of the first two operationally valid tests in the stand. The constants used for the construction of the control charts for the T-8 and T-8E, and the responses necessary in the case of control chart limit alarms, are depicted below.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart		Stand Prediction Error	
Chart Level	Lambda	Limit Type	Limit	Limit Type	Limit
Stand	0.3	Level 1	0	Level 1	±1.351
		Level 2	±1.800	Level 2	±1.734
			--	Level 3	±2.066
Industry	0.2	Level 1	±0.775	--	--
		Level 2	±0.859	--	--

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. The laboratory always has the option of removing any stand from the system.

- Exceed Laboratory chart of Prediction Error (e_i)

Level 3 (critical parameters only):

- Conduct one additional reference test in the stand that triggered the alarm. Do not update the control charts until the follow up reference test is completed and the Excessive Influence analysis (refer to Section 1.A.5) has been performed.

Level 2 (critical parameters only):

- The Level 2 limit applies in situations that have been pre-determined by the surveillance panel to have a potential impact on test results. These situations may include the introduction of new critical parts, fuel batches, reference oil reblends, or other test components. When these conditions have been met and a Level 2 alarm is triggered, immediately conduct one additional reference test in the stand that triggered the alarm. Evaluate any subsequent test(s) using Level 3 e_i limits.

Level 1 (critical parameters only):

- The Level 1 limit also applies to a stand in an existing test lab that has not run an acceptable reference in the past two years. The stand can calibrate with one test if the Level 1 limits are not exceeded. Otherwise, conduct another reference test in the stand.

- Exceed Stand EWMA of Standardized Test Result (Z_i)

  Level 2 (critical parameters only):

  - Conduct one additional reference test in the stand that triggered the alarm. The stand that triggered the alarm is not qualified for non-reference tests until the Level 2 alarm is cleared.
  - In instances where surveillance panel has deemed that industry-wide circumstances are impacting the Level 2 alarm, the TMC may be asked to review stand calibration status in accordance with the surveillance panel's findings.

  Level 1 (all parameters):

  - The Level 1 limit applies to all reference tests that are control charted, even when other alarms have been triggered. Level 1 uses Z_i to determine the stand severity adjustment (SA). Calculate the stand SA as follows and confirm the calculation with the TMC:

- Calculate stand Severity Adjustment (SA) using the current stand 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 Industry EWMA of Standardized Test Result (Z_i)

  Level 2:

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

  Level 1:

  - The TMC investigates whether severity adjustments are adequately addressing the trend, investigates the possible causes, and communicates as appropriate with industry.

41. Oil Seal Compatibility Test LTMS Requirements

The following are the specific Oil Seal Compatibility Test calibration test requirements.

A. Reference Oils and Critical Parameters

The critical parameters are Elongation, Shore Hardness, and Volume Change. The reference oils required for test stand and test laboratory calibration are the reference oils accepted by the ASTM Oil Seal Compatibility Test Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameters are presented below.

ELONGATION
Unit of Measure: Percent

Reference Oil	Elastomer	Mean	Standard Deviation
160-1	Polyacrylate	23.04	14.289
160-1	Fluoroelastomer	-47.65	5.506
161-1	Polyacrylate	68.88	17.850
161-1	Fluoroelastomer	-34.57	6.989
161-1	Nitrile	10.43	10.691
162	Nitrile	-65.35	7.330
168	Nitrile	-74.52	6.965
169	Polyacrylate	49.2	21.82
169	Fluoroelastomer	-39.5	6.99
169	Nitrile	-16.2	10.69
170	Nitrile	-72.75	3.416
171	Polyacrylate	24.167	20.929
171	Fluoroelastomer	-42.6	4.2

SHORE HARDNESS
Unit of Measure: Points

Reference Oil	Elastomer	Mean	Standard Deviation
160-1	Polyacrylate	-1.8	1.16
160-1	Fluoroelastomer	1.6	1.36
161-1	Polyacrylate	-24.9	2.83
161-1	Fluoroelastomer	1.6	1.30
161-1	Nitrile	-16.1	2.18
162	Nitrile	2.0	2.03
168	Nitrile	3.0	1.89
169	Polyacrylate	-16.0	2.83
169	Fluoroelastomer	0.1	1.30
169	Nitrile	-8.6	2.18
170	Nitrile	1.500	0.674
171	Polyacrylate	0.333	0.577
171	Fluoroelastomer	-0.667	0.577

VOLUME CHANGE
Unit of Measure: Percent

Reference Oil	Elastomer	Mean	Standard Deviation
160-1	Polyacrylate	0.343	0.4473
160-1	Fluoroelastomer	2.053	0.4075
161-1	Polyacrylate	19.624	1.4348
161-1	Fluoroelastomer	6.199	0.7080
161-1	Nitrile	18.444	1.7057
162	Nitrile	2.460	1.5821
168	Nitrile	1.326	1.4730
169	Polyacrylate	13.1	1.43
169	Fluoroelastomer	4.4	0.71
169	Nitrile	11.8	1.71
170	Nitrile	2.275	0.449
171	Polyacrylate	-0.233	0.306
171	Fluoroelastomer	1.467	0.306

B. Acceptance Criteria

1. New Test Stand

   - For each elastomer type, an operationally valid calibration test, with no Shewhart severity alarms, must be conducted on each of the two approved reference oils.

2. Existing Test Stand

   - The test stand must have been TMC calibrated prior to LTMS introduction or 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:

Elastomer Type	Oil Assignments
PA	Assign reference oils 160, 161, 169 or 171 (or subsequent reblends) for every calibration sequence.
FL	Assign reference oils 160, 161, 169 or 171 (or subsequent reblends) for every calibration sequence.
NI	Assign reference oils 161, 162, 168 or 170 (or subsequent reblends) for every calibration sequence.

47. D7528 ROBO Test LTMS Requirements

The following are the specific D7528 ROBO Test calibration requirements.

A. Reference Oils and Critical Parameters

1. The critical pass/fail parameter is MRV Apparent Viscosity of the aged oil in transformed units. The reference oils, performance targets and acceptance criteria required for the test stand calibration with the TMC are listed in Table 1 and have been approved by the ASTM D02.B0.07 ROBO Surveillance Panel.

Table 1
MRV VISCOSITY
Unit of Measure: LN(MRV)

D7528 (ROBO) Aged Oil MRV Acceptance Bands, mPa·s and ln(mPa·s)

Oil	n	Natural Log Transformed Mean (ln)	Mean in Original Units	s.d. (ln)	95% band in mPa·s Min[1]	95% band in mPa·s Max[1]	95% Bands Min (ln)	95% Bands Max (ln)
434-1	13	10.6599	42,612	0.1672	30,706	59,136	10.3322	10.9876
434-2	36	[2]10.9284	[2]55,737	0.1551	[2]41,126	[2]76,008	[2]10.6244	[2]11.2386
435	15	11.4895	97,685	0.2932	[3]60,000	173,546	[3]11.0021	12.0642
435-1	22	11.0416	62,420	0.20295	[4]44570	92910	[4]10.7048	11.4394
438	14	10.2676	28,785	0.2037	19,308	42,912	9.8683	10.6669
438-2	10	10.4421	34,273	0.2322	[2]21,742	54,025	9.9870	10.8972

[1] 95% bands in mPa·s are listed for information purposes only, the transformed values will be used to judge acceptance in all cases.
[2] A correction factor (severity adjustment) has been applied to the mean of reference oil 434-2 to account for the mild bias observed during the period this dataset was generated. The 95% confidence range reflects the inclusion of the correction factor (severity adjustment).
[3] The minimum value for Reference oil 435 is fixed at 60,000 (11.0021 in transformed units) and not a true 95% minimum as calculated from the statistics.
[4]The minimum value for reference oil 435-1 is based on -1.66 standard deviations from the target mean (to match the range previously approved for oil 435 min), so is not actually a 95% confidence range. A 95% confidence range would use 1.96 standard deviations from target mean.

2. EOT MRV (MRVEOT) viscosity values >400,000 mPa·s shall be reported as >400000.
3. EOT volatiles (VOLEOT) for the reference oils, in a properly run test, should never reach or exceed 60%. Tests with EOT volatility >= 60% will be declared operationally invalid.
4. EOT yield stress (MRVYSEOT) for the reference oils, in a properly run test, should always be <35 Pa. Tests with EOT yield stress measured or reported at anything other than <35 will be declared operationally invalid.

B. Acceptance Criteria

1. New Test Stands

a. A minimum of two (2) operationally valid calibration tests which fall within the acceptance bands for the oils assigned are required to calibrate a stand for

Oil Seal Compatibility Test Reference Oil Targets										
			Effective Dates		Elongation		Shore Hardness		Volume Change	
Oil	n	Elastomer	From[1]	To[2]	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s
160[3]	--	Polyacrylate	11-18-94	***	23.04	14.289	-1.8	1.16	0.343	0.4473
	--	Fluoroelastomer	11-18-94	***	-47.65	5.506	1.6	1.36	2.053	0.4075
160-1	144	Polyacrylate	11-18-94	***	23.04	14.289	-1.8	1.16	0.343	0.4473
	141	Fluoroelastomer	11-18-94	***	-47.65	5.506	1.6	1.36	2.053	0.4075
161[4]	--	Polyacrylate	11-18-94	***	68.88	17.850	-24.9	2.83	19.624	1.4348
	--	Fluoroelastomer	11-18-94	***	-34.57	6.989	1.6	1.30	6.199	0.7080
	--	Nitrile	11-18-94	***	10.43	10.691	-16.1	2.18	18.444	1.7057
161-1	144	Polyacrylate	11-18-94	***	68.88	17.850	-24.9	2.83	19.624	1.4348
	141	Fluoroelastomer	11-18-94	***	-34.57	6.989	1.6	1.30	6.199	0.7080
	119	Nitrile	11-18-94	***	10.43	10.691	-16.1	2.18	18.444	1.7057
162	119	Nitrile	11-18-94	***	-65.35	7.330	2.0	2.03	2.460	1.5821
168	13	Nitrile	7-7-06	2-28-09	-74.22	2.422	3.0	1.49	1.424	0.1295
	38	Nitrile	3-1-09	3-10-09	-74.52	1.599	3.0	0.79	1.326	0.1388
	38	Nitrile	3-11-09	***	-74.52	6.965[5]	3.0	1.89[5]	1.326	1.4730[5]
169	19	Polyacrylate	3-7-12	***	49.2	21.82	-16.0	2.83[6]	13.1	1.430[6]
	18	Fluoroelastomer	3-7-12	***	-39.5	6.99[6]	0.1	1.30[6]	4.4	0.71[6]
	22	Nitrile	3-7-12	***	-16.2	10.69[6]	-8.6	2.18[6]	11.8	1.710[6]
170	12	Nitrile	1-24-16	***	-72.75	3.416	1.500	0.674	2.275	0.449
171	3	Polyacrylate	8-21-18	***	24.167	20.929	0.333	0.577	-0.233	0.306
171	3	Fluoroelastomer	8-21-18	***	-42.6	4.2	-0.667	0.577	1.467	0.306

3 Effective for all tests completed on or after this date.
4 *** = currently in effect.
5 Targets based on oil 160-1.
6 Targets based on oil 161-1.
7 Standard deviation based on oil 162 (n=138).
8 Standard deviation based on oil 161-1.