

23. 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
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

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- A minimum of two (2) operationally valid calibration tests with no stand Level 3 e<sub>i</sub> 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 Level 1 e<sub>i</sub> alarms. If the first operationally valid calibration test does not meet this acceptance criterion, 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 eighteen (18) 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 Level 1 e<sub>i</sub> alarms. If the first operationally valid calibration test does not meet this acceptance criterion, 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.
- 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.

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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. 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		Laboratory Prediction Error	
Chart Level	Lambda	Limit Type	Limit	Limit Type	Limit
Lab	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):

- Immediately 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 (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 rebends, 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.

Level 1 (critical parameters only):

- The Level 1 limit also applies to 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, immediately conduct another reference test in the stand.

- Exceed Laboratory EWMA of Standardized Test Result ( $Z_i$ )

Level 2 (critical parameters only):

- Immediately conduct one additional reference test in the engine-stand that triggered the alarm. The engine-stand that triggered the alarm is not qualified for

non-reference tests and do not update the control charts until the follow up reference test is completed 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 engine-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 laboratory severity adjustment (SA). Calculate the laboratory SA as follows and confirm the calculation with the TMC:
- 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 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.