

17. 1P LTMS Requirements

The following are the specific 1P calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Top Groove Carbon, Top Land Carbon and Average Oil Consumption. The reference oils required for test stand and test laboratory calibration are reference oils accepted by the ASTM Single Cylinder Diesel Surveillance Panel. The means and standard deviations for the current reference oils for each critical and noncritical parameter are presented below.

TOP GROOVE CARBON Unit of Measure: Demerits CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-5	28.65	7.74

TOP LAND CARBON Unit of Measure: Demerits CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-5	30.88	13.15

AVERAGE OIL CONSUMPTION Unit of Measure: LN(g/h) CRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-5	1.8641	0.3238

WEIGHTED DEMERITS
Unit of Measure: Demerits
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-5	285.3	57.6

END OF TEST OIL CONSUMPTION
Unit of Measure: LN(g/h)
NONCRITICAL PARAMETER

Reference Oil	Mean	Standard Deviation
1005-5	1.6016	0.5177

B. Acceptance Criteria

1. New Test Stand

a. Less than six (6) Operationally Valid Calibration Results in Laboratory

- A minimum of two (2) operationally valid calibration tests, with no stand Shewhart severity alarms and no stand Shewhart precision alarms, must be conducted on any approved reference oils.
- 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. Six (6) 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 alarm and no stand Shewhart precision 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.

- * Only test results from calibrated stands in the laboratory count towards the tally of six (6) required operationally valid calibration tests. The sixth 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 nine (9) months of the completion of the last acceptable calibration test. Also, there must not be any outstanding precision alarms for the laboratory.

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.
- 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.

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 or subsequent approved reblend.

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 for the control charts for the 1P, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Reduced K	--	--	--	--	1.66	1.48
	Action	0.3	0.3	1.96	2.24	1.96	1.80
Lab	Warning	0.2	--	1.96	--	--	--
	Action	0.2	0.2	2.72	1.96	1.96	1.80
Industry	Warning	0.2	0.2	2.00	2.24	--	--
	Action	0.2	0.2	2.65	2.88	--	--

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)

51. D6594 High Temperature Corrosion Bench Test (HTCBT) LTMS Requirements

The following are the specific High Temperature Corrosion Bench Test calibration test requirements.

B. Calibration Details

The High Temperature Corrosion Bench Test is calibrated at the individual instrument level, by the bath used in the test. Baths are identified by ID number within a laboratory and calibrated individually. There is no laboratory level calibration in the High Temperature Corrosion Bench Test.

B. Reference Oils and Critical Parameters

The critical parameters are Copper Concentration and Lead Concentration, reported in milligrams per kilogram. The Change in Copper (Δ Cu) precision is not uniform across reference oils. A natural log transform (ln) is applied to each Δ Cu value before performing statistical evaluations. The reference oils required for instrument calibration are the reference oils accepted by the ASTM High Temperature Corrosion Bench Test Surveillance Panel. The means and standard deviations for the current reference oils for the critical parameters are presented below.

COPPER CONCENTRATION (CUC)
Unit of Measure: ln(mg/kg)

Reference Oil	Mean	Standard Deviation	Acceptance Band ^A
44-4	4.9961	0.1069	120 – 182
44-5	4.664	0.372	52 – 219
1005-5	1.8497	0.3363	3 – 12

^ATest results are compared to the Acceptance Bands in original units

LEAD CONCENTRATION (PBC)
Unit of Measure: mg/kg

Reference Oil	Mean	Standard Deviation	Acceptance Band
44-4	31.5	9.00	14 – 49
44-5	33.222	8.171	18 – 49
1005-5	9.5	7.60	0 – 24

C. Acceptance Criteria

1. New Instrument

- Operationally valid calibration tests, with results within the Acceptance Bands, must be conducted on both approved reference oils. No candidate oils shall be tested along with these runs.

1P Reference Oil Targets													
Oil	n	Effective Dates		TGC		TLC		AOC ¹		WDP		EOTOC ²	
		From	To ³	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s
1005	31	2-19-97	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-1 ⁵	--	6-6-98	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-2 ⁵	--	7-15-05	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-3 ⁵	--	12-30-09	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-4 ⁵	--	06-01-13	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1005-5 ⁵	--	02-04-15	***	28.65	7.74	30.88	13.15	1.8641	0.3238	285.3	57.6	1.6016	0.5177
1004-3	31	2-19-97	***	29.48	7.74	28.12	13.15	1.8321	0.3238	319.6	57.6	2.0492	0.5177
PC-7C ⁴	31	2-19-97	***	42.63	7.74	42.03	13.15	2.8999	0.3238	390.2	57.6	3.4664	0.5177
PC-7D ⁴	31	2-19-97	***	31.71	7.74	40.29	13.15	1.9572	0.3238	307.6	57.6	2.0719	0.5177
PC-7E ⁴	31	2-19-97	***	32.53	7.74	37.52	13.15	1.9252	0.3238	341.9	57.6	2.5195	0.5177
PC-7F ⁴	31	2-19-97	***	45.68	7.74	51.44	13.15	2.9930	0.3238	412.5	57.6	3.9367	0.5177
PC-7G ⁴	31	2-19-97	***	25.49	7.74	29.87	13.15	1.8680	0.3238	279.7	57.6	1.5609	0.5177
PC-7H ⁴	31	2-19-97	***	26.32	7.74	27.11	13.15	1.8360	0.3238	314.0	57.6	2.0084	0.5177
PC-7J ⁴	31	2-19-97	***	39.46	7.74	41.02	13.15	2.9039	0.3238	384.6	57.6	3.4257	0.5177

- 1 Transformation for AOC is $\ln(\text{AOC})$
- 2 Transformation for EOTOC is $\ln(\text{EOTOC})$
- 3 *** = currently in effect
- 4 Oil used only for precision matrix
- 5 Targets based on 1005

D6594 High Temperature Corrosion Bench Test (HTCBT) Reference Oil Targets							
Oil	n	Effective Dates		LN(Copper Concentration Change)		Lead Concentration Change	
		From ¹	To ²	$\bar{X}$	S	$\bar{X}$	s
42	9	11980113	19990315	3.857	0.2490	89.73	19.71
	55	19990316	20050309	3.2232	0.5828	107.813	23.7695
44	30	20060201	20081121	4.4803	0.3426	54.1	15.3
44-1	9	20090505	20091108	4.8820	0.1061	41.3	10.3
	168	20091109	20120522	4.8349	0.1351	46.3	11.2
44-2	15	20100505	20141202	4.8808	0.1349	43.9	11.1
44-3	11	20130124	20130421	4.8052	0.1447	43.8	6.7
	34	20130422	20190722	4.8107	0.1038	40.3	8.2
44-4	21	20170429	20170429	4.9778	0.0939	34.7	11.6
	177	20170430	20190630	4.9961	0.1069	31.5	9.0
	177	20190701	***	4.9961	0.1069	31.5	9.0
44-5	16	20230303	20231102	4.7446	0.2071	33.0	6.3666
	49	20231103	20260921	4.8268	0.3608	32.76	7.6520
	18	20260922	***	4.664	0.372	33.222	8.171
1005	8	19980113	19990315	2.0740	0.2490	25.43	6.0100
	60	19990316	20100224	2.2554	0.1409	32.2317	13.0282
1005-1	8	20091221	20110920	2.5986	0.1069	56.2	6.8
1005-3	15	20100505	20181005	1.8469	0.1794	18.3	7.1
1005-5	12	20151104	20151220	1.8005	0.1831	10.3	5.8
	30	20151221	20160619	1.8740	0.2137	11.4	9.1
	138	20160620	20190630	1.8497	0.3363	9.5	7.5
	138	20190701	***	1.8497	0.3363	9.5	7.5

1 Effective for all tests completed on or after this date.

2 *** = currently in effect.