8. Sequence IX LTMS Requirements

The following are the specific Sequence IX calibration test requirements.

A. Reference Oils and Critical Performance Criteria

The critical performance criteria is Average Number of Preignitions (AVPIE). Additionally, an upper limit is set on Maximum Pre-ignition events. The reference oils required for test stand and test laboratory referencing are reference oils accepted by the ASTM Sequence IX Surveillance Panel. The means and standard deviations for the current reference oils for each critical performance criterion are presented below.

Average Number of Preignitions (AVPIE)
Unit of Measure: Square Root (AVPIE+0.5)

Reference Oil	Mean	Standard Deviation
221	3.3819	0.3775
221-1	3.3819	0.3775
224	2.0445	0.3775
224-1	2.0445	0.3775
224-2	2.0445	0.3775

Maximum Number of Preignitions (MAXPIE)
Unit of Measure: Square Root (MAXPIE+0.5)

Reference Oil	Targets
All Oils	N/A

B. Acceptance Criteria

1. New Test Stand/Engines

- A minimum of two (2) operationally valid calibration tests, with no Level 0 e_i or Level 2 Z_i alarms after the second operationally valid test must be conducted in a new stand-engine on any approved reference oils. If the above criteria cannot be met then a minimum of three (3) operationally valid calibration tests, with no Level 3 e_i or level 2 Z_i alarms after the third operationally valid test must be conducted in a new stand-engine on any approved reference oils.

- Additionally, engines using pistons other than BB grade pistons originally installed in the engine will be required to demonstrate discrimination by meeting the criteria of less than AVPIE of 2.12 for four consecutive valid iterations on RO220 (or subsequent reblends). These results will not be used for charting purposes.

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

2. Existing Test Stand/Engine

- The stand/engine must have previously been accepted into the system by meeting the LTMS requirements

- Existing test stand-engines that have run an acceptable reference in the past 180 days may calibrate with 1 test.

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

3. Reference Oil Assignment

Once test stand-engines have been accepted into the system, the TMC will assign reference oils for continuing calibration according to the reference oil mix:

- Scheduled calibration tests should be conducted on reference oils 221 and 224 or subsequent approved reblends in equal proportion with random assignment.

4. Control Charts

In Section 1, the construction of the control charts that contribute to the Lubricant Test Monitoring System is outlined. For the Sequence IX, Z_0=Mean Y_i of all operationally valid tests in the initial stand-engine calibration sequence. The constants used for the construction of the control charts for the Sequence IX, and the response necessary in the case of control chart limit alarms, are depicted below.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart		Stand-Engine Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand-Engine		0.4		Level 0	±1.000
	Level 1		0.000	Level 1	±1.351
	Level 2		±1.500	Level 2	±1.734
				Level 3	±2.066
Industry	Level 1	0.2	±0.775	-	-
	Level 2		±0.859	-	-

Sequence IX Oil Targets					
Oil	n	Effective Dates		AVGPIE	
		From[1]	To[2]	$\overline{X}$	s[3]
221	8[4]	4-21-17	6-27-19	3.3819	0.3609
221	8[4]	6-28-19	***	3.3819	0.3775
221-1[5]	--	3-20-25	***	3.3819	0.3775
222	16[4]	4-21-17	***	4.2644	0.2694
224	9	6-28-19	***	2.0445	0.3775
224-1	9	5-1-23	***	2.0445	0.3775
224-2	9	8-9-24	***	2.0445	0.3775

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Pooled s from matrix analysis.
4 Matrix + additional tests n-size.
5 Targets based on oil 221

ISB Reference Oil Targets							
		Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss	
Oil	n	From	To[1]	$\overline{X}$	s	$\overline{X}$	s
821 (PC10E)	6	6-4-05	12-31-05	34.6	4.6	56.2	9.6
830-2	6	6-4-05	12-31-05	39.8	9.0	85.9	16.0
831 (PC10B)	6	6-4-05	1-24-07	41.9	5.6	88.7	15.9
	10	1-25-07	8-6-07	42.8	5.4	94.9	15.3
	14	8-7-07	***	42.5	5.0	97.2	14.8
831-1[2]	--	8-7-07	10-18-17	42.5	5.0	97.2	14.8
831-1[2]	--	10-19-17	***	42.5	8.7	97.2	14.8
831-2[2]	--	8-6-13	10-18-17	42.5	5.0	97.2	14.8
831-2[2]	--	10-19-17	***	42.5	8.7	97.2	14.8
831-3[2]	--	8-11-15	10-18-17	42.5	5.0	97.2	14.8
831-3[2]	--	10-19-17	9-03-20	42.5	8.7	97.2	14.8
831-3	--	9-4-20	6-30-21	52.4	9.2	97.2	14.8
831-1[3]	--	7-1-21	***	3.7495	0.2302	9.8590	1.1755
831-4[2]	--	6-14-17	10-18-17	42.5	5.0	97.2	14.8
831-4[2]	--	10-19-17	9-03-20	42.5	8.7	97.2	14.8
831-4	--	9-4-20	6-30-21	52.4	9.2	97.2	14.8
831-4[3]	--	7-1-21	***	3.7495	0.2302	9.8590	1.1755
835[3]	8	7-1-21	***	3.9338	0.2302	9.7057	1.1755

1 *** = currently in effect
2 Targets based on oil 831
3 Transformed units LN(ACSW) and SQRT(ATWL)