10. Sequence VIE LTMS Requirements

The following are the specific Sequence VIE calibration test requirements.

A. Reference Oils and Critical Parameters

The critical parameters are Fuel Economy Improvement at 16 hours (FEI1) and Fuel Economy Improvement at 109 hours (FEI2). The reference oils required for test stand/engine calibration are reference oils accepted by the ASTM Sequence VI Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

FUEL ECONOMY IMPROVEMENT at 16 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
542-2	2.56	0.280
542-3	2.56	0.280
542-4	2.56	0.280
542-5	2.56	0.280
544	1.30	0.214
1010-1	1.90	0.199
1010-2	1.90	0.199

FUEL ECONOMY IMPROVEMENT at 109 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
542-2	1.73	0.260
542-3	1.73	0.260
542-4	1.73	0.260
542-5	1.73	0.260
544	1.41	0.256
1010-1	1.82	0.327
1010-2	1.82	0.327

B. Reference Oil Assignment:

100% of the scheduled calibration tests shall be conducted on reference oils 542, 544, and 1010 or subsequent approved reblends with reference oils 542 and 1010 assigned 40% each and reference oil 544 assigned for 20% of reference attempts. If possible, the same oil should not be used for successive calibration tests in a stand.

11. Sequence VIF LTMS Requirements

The following are the specific Sequence VIF calibration test requirements.

A. Reference Oils and Critical Parameters

The critical parameters are Fuel Economy Improvement at 16 hours (FEI1) and Fuel Economy Improvement at 109 hours (FEI2). The reference oils required for test stand/engine calibration are reference oils accepted by the ASTM Sequence VI Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

FUEL ECONOMY IMPROVEMENT at 16 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
542-2	2.23	0.18
542-3	2.23	0.18
542-4	2.23	0.18
542-5	2.23	0.18
1011	1.45	0.14
1011-1	1.45	0.14
543	1.88	0.27

FUEL ECONOMY IMPROVEMENT at 109 Hours
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
542-2	1.52	0.13
542-3	1.52	0.13
542-4	1.52	0.13
542-5	1.52	0.13
1011	1.41	0.39
1011-1	1.41	0.39
543	2.25	0.34

37. D5133 (GI) TMC Calibration Requirements

The following are the specific D5133 (GI) TMC calibration test requirements.

Objective of TMC monitoring of D5133 (GI) test stands: The surveillance panel's intent is that each participating GI instrument head (viscometer drive module) and test cell (rotor and stator) combination must demonstrate accurate D5133 test performance on blind reference oils of known and varied GI severity performances at least once every 180 days, and demonstrate a passing result on a low-gelling (discrimination) reference oil every other calibration run (or, at least once every 360 days). The following requirements are intended to meet these objectives.

A. Reference Oils and Critical Parameters

1. The critical pass/fail parameter is Gelation Index (a unitless, derived value that measures the gelling tendency characteristics of a tested fluid). The reference oil performance targets and acceptance criteria required for calibration with the TMC are listed in Table 1 and have been approved by the ASTM D02.B0.07 Gelation Index Surveillance Panel.

2. Per the D5133 test method, a GI result less than 6.0 shall be reported as '<6.0', and GI result of 6.0 or greater shall be reported as a numeric value to one decimal.

Table 1
D5133 Reference Oil Targets and Acceptance Bands

						Acceptance Bands[1] 95%	
Test	**Oil Code**	**Parameter**	**n**	**Mean**	**sR**	**Lower**	**Upper**
GI by D5133	1009	Gelation Index	16	7.3	0.68	6.0	8.6
	62	Gelation Index	35	17.0	3.90	9.4	24.6
	GIA17	Gelation Index	18	19.0	1.87	15.4	22.7
	GIC18	Gelation Index	13	10.3	1.21	7.9	12.7
	58[2]	Gelation Index	17	<6.0	N/A	<6.0	7.2

[1] 95% Acceptance Bands = Mean +/- (1.960 x sR)
[2] Discrimination Oil

B. Test Stand Defined

1. A GI test stand is defined as a single Scanning Brookfield head (also referred to in the test method as a 'Viscometer Drive Module'), and a single rotor and stator (test cell) combination and in conformance with ASTM Test Method D5133. The test sample and test cell may be cooled by liquid bath, air or thermoelectrically. The test cell may be cooled in a common cooling bath with other test cells, or by temperature controlled blocks with one or more test cells. Each stand (head and test cell combination) is to be identified by a unique manufacturers head serial number.
2. Testing labs are permitted to limit participation to any number of test stands on a multi-head instrument (or controller) with this notification that any test stands that are not

- Repair of a central controller
- Replacement of a cooling bath thermocouple

In the event of a failing calibration run, the lab shall verify the change was not the reason for the failure by running a calibration run on another test stand on the same controller system. The failing test stand will follow the calibration requirement listed in section C.2.

3. Tracking and Reporting Test Stand Runs
   a. A stand's calibration status shall be tracked by the TMC through reported Instrument ID and Head Run Numbers. Instrument ID and Head Run Number are separate fields on the approved data dictionary. An example is:
      Instrument ID: C123456(C20)
      Head Run Number: 123456 (C10)

   b. Instrument ID shall be the serial number of the head that produced the test result being reported, and represents the monitored test stand. Repaired or overhauled heads will be reset in the test monitoring system per Section C.6.b.

   c. Head Run Number shall be a consecutive integer count of test starts on a head. Head Run Number is increased incrementally by one (1) for each new test start on a head, regardless of whether or not the test runs to completion, or whether or not the run is a TMC calibration attempt. Head Run Number will be reset to 1 for new or newly repaired heads.

4. Blind Calibration Test Evaluation:

   a. The calibration status of a test stand will be based on a review of reported operational parameters for compliance with the test method, followed by a statistical evaluation of the critical parameter test result against the acceptance ranges in Section A (commonly referred to as a Shewhart severity evaluation). Unless otherwise noted, the acceptance bands in Table 1 are based on a 95% confidence treatment of round robin test results with data exclusions as approved by the surveillance panel.

   b. Unless otherwise addressed by the panel, any operationally valid GI test result reported as '<6.0' for any non-discrimination reference oil cannot be statistically interpreted. Such reported test results will be given a validity that indicates the result is operationally valid but not statistically interpretable, and therefore not chartable. (Validity OC, Chart N)

5. Discrimination Oil Test Criteria:

   a. In order to demonstrate that the test stand can discriminate a borderline non-gelling oil from the reference oils that have measurable gelling characteristics, a low-to-non-gelling discrimination oil (TMC oil 58 or an approved replacement) shall be requested and assigned on every calibrated test stand initially (per C.1.a) and at least once every 360 days, and run consecutively

Sequence VH Reference Oil Targets												
Oil	n	Effective Dates		AES		RAC		AEV50		APV50		Hot Stuck Rings
		From[1]	To[2]	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	$\bar{X}$	s	Maximum Allowable
931	6	20210316	***	8.00	0.60	0.2283	0.5715	8.97	0.30	8.35	0.60	0
940	7	20170128	20221129	6.47	0.49	0.9155	0.2260	8.77	0.28	7.35	0.64	0
940	7	20221130[3]	***	6.47	0.49	0.8041	0.2340	8.77	0.28	7.35	0.64	0
1009	8	20170128	20211115	7.21	0.44	0.0515	0.3139	8.81	0.40	7.89	0.74	0
1011	7	20170128	***	8.43	0.57	-0.5294	0.1924	9.26	0.21	8.67	0.48	0
1011-1	7	20220104	***	8.43	0.57	-0.5294	0.1924	9.43	0.21	8.96	0.48	0

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Rocker Cover target recalculated for reference oil 940 recalculated using all results on fuel batch DJ0321NX10, number of tests =21, severity adjustments recalculated using new targets.

Sequence VIE Reference Oil Targets							
Oil	n	Effective Dates		FEI1		FEI2	
		From[1]	To[2]	$\overline{X}$	s^3	$\overline{X}$	s^3
542-2	9	12-13-15	03-13-18	2.56	0.31	1.73	0.30
542-3	9	12-13-15	03-13-18	2.56	0.31	1.73	0.30
544	9	12-13-15	03-13-18	1.30	0.26	1.41	0.20
1010-1	11	12-13-15	03-13-18	1.90	0.27	1.82	0.25
542-2[4,5]	45	03-14-18	***	2.56	0.280	1.73	0.260
542-3[4,5]	45	03-14-18	***	2.56	0.280	1.73	0.260
542-4[6]	45	10-01-19	***	2.56	0.280	1.73	0.260
542-5[6]	45	01-01-23	***	2.56	0.280	1.73	0.260
544[4,5]	43	03-14-18	***	1.30	0.214	1.41	0.256
1010-1[4,5]	39	03-14-18	***	1.90	0.199	1.82	0.327
1010-2[6]	39	01-01-23	***	1.90	0.199	1.82	0.327

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Pooled s from precision matrix analysis.
4 Pooled s from 134 reference tests completed through 2/19/18 including first run results from the matrix analysis.
5 Targets are also to be applied to the three previous stand results where the industry correction factor was applied to calculate the stand Zi.
6 Targets from previous blend(s) used for this blend.

Sequence VIF Reference Oil Targets							
Oil	n	Effective Dates		FEI1		FEI2	
		From[1]	To[2]	$\overline{X}$	s[3]	$\overline{X}$	s[3]
542-2	6	11-22-15	***	2.23	0.18	1.52	0.13
542-3[4]	6	11-20-17	***	2.23	0.18	1.52	0.13
542-4[4]	6	09-20-19	***	2.23	0.18	1.52	0.13
542-5[4]	6	01-10-23	***	2.23	0.18	1.52	0.13
1011	5	11-22-15	***	1.45	0.14	1.41	0.39
1011-1[4]	5	01-13-21	***	1.45	0.14	1.41	0.39
543	7	11-22-15	***	1.88	0.27	2.25	0.34

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 Pooled s from precision matrix analysis.
4 Targets from previous blend(s) used for this blend.

D5133 (GI) Test Reference Oil Targets					
		Effective Dates		Gelation Index	
Oil	n	From[1]	To[2]	$\overline{X}$	s
1009	16	20030715	***	7.3	0.68
51	10	19960401	19961231	65.4	12.6
51	35	19970101	20010702	63.3	12.01
52	11	19960401	19961231	4.4	0.20
52	35	19970101	20030714	4.5	0.24
53	11	19960401	19961231	45.3	3.70
53	37	19970101	20030714	44.7	4.64
55	10	19960401	19961231	22.6	5.10
55	36	19970101	20010702	22.3	4.84
58	17	20011024	20200930	5.8	0.69
58[3]	17	20201001	***	<6.0	N/A
62	10	19960401	19961231	15.7	4.70
62	35	19970101	***	17.0	3.90
GIA17	18	20190409	***	19.0	1.87
GIC18	13	20221027	***	10.3	1.21

[1] Effective for all tests completed on or after this date.
[2] *** = currently in effect.
[3] Discrimination Oil