

7. Sequence VG LTMS Requirements

The following are the specific Sequence VG calibration test requirements.

A. Reference Oils and Parameters

The critical parameters are Average Engine Sludge, Average Rocker Cover Sludge, Average Engine Varnish, Average Piston Varnish, and Oil Screen Clogging. Number of Hot Stuck Rings is a discrete parameter and is monitored for occurrence only. The reference oils required for stand calibration are the reference oils accepted by the ASTM Sequence VG Surveillance Panel. The means and standard deviations for the current reference oils for each critical parameter are presented below.

AVERAGE ENGINE SLUDGE

Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
925-3	6.49	0.55
1006	8.43	0.60
1006-2	8.65	0.41
1007	8.93	0.30
1009	7.94	0.52

AVERAGE ROCKER COVER SLUDGE

Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
925-3	7.43	0.44
1006	9.35	0.20
1006-2	9.40	0.15
1007	8.99	0.41
1009	9.29	0.18

AVERAGE ENGINE VARNISH

Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
925-3	8.56	0.25
1006	9.27	0.10
1006-2	9.24	0.12
1007	9.24	0.11
1009	8.99	0.22

AVERAGE PISTON VARNISH

Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
925-3	7.38	0.36
1006	8.49	0.18
1006-2	8.52	0.22
1007	8.57	0.23
1009	7.79	0.43

OIL SCREEN CLOGGING

Unit of Measure: LN(OSCRNSLG + 1)

Reference Oil	Mean	Standard Deviation
925-3	3.997	0.669
1006	1.384	0.850
1006-2	0.896	0.579
1007	0.968	0.614
1009	2.200	1.038

NUMBER OF HOT STUCK RINGS

Unit of Measure: Count

Reference Oil	Maximum Allowable
925-3	0
1006	0
1006-2	0
1007	0
1009	0

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 except 925-3.
- All operationally valid calibration results must be charted to determine if the test stand is currently “in control” as defined by the control chart from the Lubricant Test Monitoring System.

determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance.

- Exceed the EWMA laboratory chart action limit for precision
 - Cease all candidate starts in the laboratory. Develop plan to correct laboratory precision problem. Coordinate efforts with the TMC.
- Exceed EWMA laboratory chart warning limit for precision
 - Immediately begin two (2) calibration tests on calibrated test stands different from the test stand which exceeded the warning limit. (Calibration tests currently running on “existing” test stands may be used.) If a laboratory has two (2) test stands, conduct one (1) calibration test in each of those two (2) stands. If a laboratory has only one (1) test stand, conduct two (2) additional calibration tests in that test stand. Notify the TMC for potential laboratory visit. Candidate testing may continue on other calibrated test stands.
- Exceed EWMA test stand chart limit for precision
 - Remove test stand from the system. Notify the TMC. Correct test stand precision problem. Follow requirements for entry of a new test stand into the system.
- Exceed Shewhart test stand chart limit for precision
 - Conduct an additional calibration test.
- Exceed Shewhart laboratory chart limit for precision
 - Notify TMC for guidance.
- Exceed EWMA laboratory chart limit for severity
 - Calculate laboratory Severity Adjustment (SA) for each parameter that exceeds action limit, using the current laboratory EWMA (Z_i) as follows:

AES:	$SA = (-Z_i) \times (0.45)^*$
RCS:	$SA = (-Z_i) \times (0.25)^*$
AEV:	$SA = (-Z_i) \times (0.16)^*$
APV:	$SA = (-Z_i) \times (0.31)^*$
OSCRNSLG (Transformed Scale):	$SA = (-Z_i) \times (0.793)^*$

 - * Pooled s based on reference oils 1006, 1006-2, 1007, and 1009
 - Confirm calculations with TMC

Sequence VG Reference Oil Targets														
Oil	n	Effective Dates		AES		RCS		AEV		APV		OSCRNSLG ⁷		Hot Stuck Rings
		From ¹	To ²	\bar{X}	S	\bar{X}	s	\bar{X}	s	\bar{X}	s	\bar{X}	s	Maximum Allowable
925-3	4	11-17-00	5-31-01	6.44	0.83	7.60	0.36	8.52	0.29	7.39	0.41	3.992	1.018	0
	10	6-1-01	11-02-04	6.23	0.62	7.38	0.45	8.57	0.24	7.40	0.28	4.147	0.649	0
	22	11-3-04	5-2-05	6.51	0.60	7.40	0.48	8.58	0.20	7.38	0.28	4.084	0.665	0
	26	5-3-05	7-28-11	6.49	0.55	7.43	0.44	8.56	0.20	7.38	0.26	3.997	0.669	0
	30	7-29-11	***	6.49	0.55	7.43	0.44	8.56	0.25 ⁷	7.38	0.36 ⁷	3.997	0.669	0
1006	18 ⁴	9-16-98	5-31-99	6.64	0.61 ³	8.23	0.56 ³	8.91	0.23 ³	7.72	0.32 ³	4.615	1.313 ³	0
	14 ⁶	6-1-99	11-15-99	8.11	0.68 ⁵	9.28	0.32 ⁵	9.25	0.10 ⁵	8.48	0.26 ⁵	1.680	0.645 ⁵	0
	10	11-16-99	5-24-00	8.35	0.72	9.34	0.26	9.27	0.12	8.56	0.20	1.412	0.828	0
	20	5-25-00	11-16-00	8.29	0.60	9.31	0.21	9.26	0.11	8.51	0.20	1.342	0.894	0
	29	11-17-00	***	8.43	0.60	9.35	0.20	9.27	0.10	8.49	0.18	1.384	0.850	0
1006-2	10	1-27-03	1-4-04	8.64	0.31	9.37	0.14	9.26	0.10	8.54	0.12	1.092	0.782	0
	20	1-5-04	11-02-04	8.69	0.42	9.41	0.16	9.25	0.11	8.54	0.13	0.918	0.649	0
	30	11-03-04	7-28-11	8.65	0.41	9.40	0.15	9.24	0.11	8.52	0.14	0.896	0.579	0
	30	7-29-11	***	8.65	0.41	9.40	0.15	9.24	0.12 ⁷	8.52	0.22 ⁷	0.896	0.579	0
1007	18 ⁴	9-16-98	5-31-99	7.02	0.61 ³	7.72	0.56 ³	8.88	0.23 ³	7.83	0.32 ³	4.581	1.313 ³	0
	14 ⁶	6-1-99	11-15-99	9.16	0.68 ⁵	9.25	0.32 ⁵	9.28	0.10 ⁵	8.64	0.26 ⁵	0.462	0.645 ⁵	0
	10	11-16-99	11-16-00	8.94	0.28	9.06	0.30	9.24	0.09	8.59	0.13	0.801	0.667	0
	29	11-17-00	7-28-11	8.93	0.30	8.99	0.41	9.24	0.09	8.57	0.16	0.968	0.614	0
	30	7-29-11	***	8.93	0.30	8.99	0.41	9.24	0.11 ⁷	8.57	0.23 ⁷	0.968	0.614	0
1008	18 ⁴	9-16-98	8-13-99	9.00	0.61 ³	8.94	0.56 ³	9.16	0.23 ³	8.97	0.32 ³	0.660	1.313 ³	0
1009	3	8-1-02	10-4-02	8.00	0.22	9.25	0.09	8.93	0.16	7.80	0.54	1.823	0.739	0
	5	10-5-02	5-14-03	7.78	0.36	9.15	0.22	8.93	0.11	7.84	0.40	2.670	1.303	0
	10	5-15-03	2-16-04	7.82	0.46	9.23	0.19	9.01	0.16	7.85	0.33	2.362	1.337	0
	20	2-17-04	11-02-04	7.87	0.43	9.29	0.19	9.00	0.15	7.80	0.29	2.274	1.044	0
	30	11-03-04	7-28-11	7.94	0.52	9.29	0.18	8.99	0.11	7.79	0.28	2.200	1.038	0
	30	7-29-11	***	7.94	0.52	9.29	0.18	8.99	0.22 ⁷	7.79	0.43 ⁷	2.200	1.038	0

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

2 *** = currently in effect.

3 Pooled s from GF-3 matrix analysis.

4 GF-3 matrix n-size.

5 Pooled s from fuel matrix analysis

6 Fuel matrix n-size

7 Updated AEV and APV standard deviations using last 30 tests, including fuel approval results for oil 925-3, 1006-2, 1007 and 1009

APPENDIX C
HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS

Test	Parameter	s	Effective Dates	
			From	To
Sequence IIIF	VIS80	0.0129546	20000610	***
	APV	0.220	20000610	***
	WPD	0.658	20000610	***
	VIS60	0.17334	20011115	***
Sequence IIIG	PVIS	0.2919	20030501	***
	WPD	0.60	20030501	***
	ACLW	0.1936	20030501	20040120
		0.1903	20040121	***
Sequence IIIGA	MRV Viscosity	0.30763	20031103	20040526
Sequence IIIGB	Phos. Retention	2.33	20081112	***
Sequence IVA	ACW	9.47	19980819	20010524
		12.50	20010525	20050630
		12.52	20050701	***
Sequence VG	AES	0.61	19980916	19990531
		0.68	19990601	19991115
		0.55	19991116	20000524
		0.51	20000525	20001116
		0.47	20001117	20041231
		0.45	20050101	***
	RCS	0.56	19980916	19990531
		0.32	19990601	19991115
		0.28	19991116	20000524
		0.24	20000525	20001116
		0.33	20001117	20041231
		0.25	20050101	***
	AEV	0.23	19980916	19990531
		0.10	19990601	19991115
		0.11	19991116	20000524
		0.10	20000525	20001116
		0.09	20001117	20041231
		0.10	20050101	20110728
		0.16	20110729	***
	APV	0.32	19980916	19990531
		0.26	19990601	19991115
		0.17	19991116	20000524
		0.18	20000525	20001116
		0.17	20001117	20041231
		0.20	20050101	20110728
		0.31	20110729	***
	OSCRNSLG	27.34	19980916	19990531
		18.10	19990601	19991115
		3.40	19991116	20000524
		0.828 ¹	20000525	20001116
		0.742 ¹	20001117	20041231

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS (Continued)

Test	Parameter	s	Effective Dates	
			From	To
Sequence VG	OSCRNSLG	0.793 ¹	20050101	***
Sequence VIB	FEI1	0.18	19980825	***
	FEI2	0.17	19980825	***
Sequence VID	FEI1	0.14	20090422	20091202
	FEI2	0.16	20090422	20091202
	FEI1	0.12	20091203	***
	FEI2	0.14	20091203	***
Sequence VIII	TBWL	3.40	19980829	19991116
		5.28	19991117	20020205
		4.80	20020206	***
	10hr. Stripped Vis.	None	--	--
1M-PC	WTD	50.5	19930914	***
	TGF	16.1	19930914	***
1K	WDK	35.6	19900506	***
	TGF	15.7	19900506	***
	TLHC	1.1	19900506	***
	OC	None	--	--
1N	WDN	27.1	19930314	***
	TGF	14.6	19930314	***
	TLHC	0.9	19930314	***
	OC	None	--	--
1P	TGC	7.740	19970219	***
	TLC	13.150	19970219	***
	AOC	0.3238	19970219	***
	WDP	57.60	19970219	***
	EOTOC	0.5177	19970219	***
1R	WDR	29.0	20010701	***
	TGC	9.70	20010701	***
	TLC	7.84	20010701	***
	IOC	1.32	20010701	***
	EOTOC	1.35	20010701	***
C13	TGC	None	--	--
	TLC	None	--	--
	OCA	None	--	--
	R2TC	None	--	--
ISB	Camshaft Wear	None	--	--
	Tappet Wt. Loss	None	--	--
ISM	X-Head Wear	None	--	--
	OFDP	None	--	--
	Average Sludge	None	--	--
	Adj. Screw Wear	None	--	--

1 Transformation $\ln(\text{OSCRNSLG} + 1)$ adopted 20000525.

HISTORY OF SEVERITY ADJUSTMENT (SA)
STANDARD DEVIATIONS (Continued)

Test	Parameter	s	Effective Dates	
			From	To
T-8	Vis. Inc. @ 3.8%	1.19	19940401	19960930
	Vis. Inc. @ 3.8%	0.93	19961001	19990131
	Vis. Inc. @ 3.8%	0.90	19990201	***
T-8E	Rel. Vis. @ 4.8% 50% DIN Shear	0.26	19970127	***
	Rel. Vis. @ 4.8% 100% DIN Shear	0.27	20020306	***
T-10A	MRV Viscosity	511	20001201	20020115
		643	20020116	20020924
		496	20020925	20030121
		497	20030122	***
T-11	Soot@4.0 cSt Vis	0.23	20050528	***
	Soot@12.0 cSt Vis	0.21	20030308	***
	Soot@15.0 cSt Vis	0.26	20050528	***
	MRV Viscosity	1097	20030308	***
T-12	Cyl. Liner Wear	1.6	20050219	***
	Top Ring Wt. Loss	24.9	20050219	***
	Oil Consumption	0.0610	20050219	***
	Δ PB @ EOT	0.2880	20050219	***
	Δ PB 250-300 h	0.3630	20050219	***
RFWT	Ave. Wear	0.08	19930527	19941016
	Ave. Wear	0.05	19941017	19950625
	Ave. Wear	0.04	19950626	***
EOAT	Average Aeration	0.25	19990101	***
T-12A	MRV Viscosity	331	20100216	***
L-33-1	Rust	0.350	20020611	***
L-37 Nonlubrited	Pinion Ridging	0.666	19000101	***
	Pinion Rippling	0.557	19000101	***
	Pinion Spitting	0.847	19000101	***
	Pinion Wear	0.713	19000101	***
L-37 Lubrited	Pinion Ridging	1.430	19000101	***
	Pinion Rippling	0.476	19000101	***
	Pinion Spitting	0.579	19000101	***
	Pinion Wear	0.519	19000101	***