

Test Monitoring Center

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D4485 Information Letter 22-1 Sequence Number 15 January 10, 2022

ASTM consensus has not been obtained on this information letter. An appropriate ASTM ballot will be issued in order to achieve such consensus.

TO: D4485 Mailing List

SUBJECT: Added SP Category to Introduction and "category" Definition Added Sequence IVB Test Method to the Standard Revisions to Existing Categories for Obsolete Test Types Revised Measured High Temperature High Shear Description in CI-4 and CJ-4 Tables Revised Appendix X2 to Remove Individual Category Tables Removed Obsolete Category Appendixes X5, X7, and X10 Revised Appendixes X4, X5, X6, X7, & X8 Replacement Appendixes

At the December 8, 2021, meeting of the D4485 Surveillance Panel, the Panel approved the following revisions to Standard D4485:

API Service Category SP was added to the Introduction and to the definition of "category" in 3.1.2.

The Sequence IVB test (D8350) was added to the referenced documents in 2.1 and to several tables.

The SJ Category section contained several references to obsolete tests that have been superseded by newer versions (4.1.1.2, 4.1.1.3). The SL Category section contained several references to obsolete tests that have been superseded by newer versions (4.1.2.1, 4.1.2.4). The CH-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.3.7). The CI-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.4.5) The CJ-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.4.7).

The High Temperature High Shear parameter label in several of the Diesel Category tables did not match, but it is the same parameter for all Categories, so the CI-4 & CJ-4 tables were revised to match the CK-4 table.

Appendix X2 was revised to relocate the tables containing details about an individual Category to the Appendix covering that Category. (See additional information below.)

Obsolete Category Appendixes X5 (GF-4), X7 (GF-5), and X10 (SH) were removed and subsequent Appendixes were renumbered.

Appendix X8 (SP) was created from sections removed from the previous X2. Appendixes X4 (MACK T-10), X5 (GF-6A/GF-6B), X6 (SM), and X7 (SN, SN Plus) were only revised to change their location within the Standard.

Numerous erroneous section references in the Appendixes were corrected in this process. Due to the extensive revisions done to the Appendixes, a full replacement version is included to help insure the

new version is correct. Appendix X1, X3, and X4 were not revised in this process, but were included for clarity.

Several other tables in the Standard were revised to correct some formatting errors that existed in the current version and are also attached.

Note that any highlighting shown in the updated sections is only to draw attention to edits or revisions and will be removed before publication in the Standard.

The text of the revisions is shown in the attachment. These changes are effective with the issuance of this information letter.

Joe Franklin Chairman ASTM Subcommittee B

Attachment c: <u>http://www.astmtmc.org/ftp/docs/d4485/IL_22-1_D4485.pdf</u> Distribution: Email

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Revises ASTM Specification D4485-20 INTRODUCTION

This specification covers all the currently active American Petroleum Institute (API) engine oil performance categories that have been defined in accordance with the ASTM consensus process. There are organizations with specifications not subject to the ASTM consensus process, such as the International Lubricant Standardization and Approval Committee (ILSAC), American Petroleum Institute (API – SM, SN SP Specifications), and the Association des Constructeurs Europeans d'Automobiles (ACEA). Certain of these specifications, which have been defined primarily by the use of current ASTM test methods, have also been included in the Appendixes for information.

In the ASTM system, a specific API designation is assigned to each category. The system is open-ended, that is, new designations are assigned for use with new categories as each new set of oil performance characteristics are defined. Oil categories may be referenced by engine builders in making lubricant recommendations, and used by lubricant suppliers and customers in identifying products for specific applications. Where applicable, candidate oil programs are conducted in accordance with the American Chemistry Council (ACC) Petroleum Additives Product Approval Code of Practice.

Other service categories not shown in this document have historically been used to describe engine oil performance (SA, SB, SC, SD, SE, SF, SG, SH and CA, CB, CC, CD, CD-II, CE, CF, CF-2, CF-4, CG-4) (see 3.1.2). SA is not included because it does not have specified engine performance requirements. SH is not included because it was a category that could not be licensed for gasoline engine oil use in the API Service Symbol after Dec. 2, 2010. The others are not included because they are based on test methods for which engine parts, test fuel, or reference oils, or a combination thereof, are no longer available. Also, the ASTM 5-Car and Sequence VI Procedures are obsolete and have been deleted from the category Energy Conserving and Energy Conserving II (defined by Sequence VI). Information on excluded older categories and obsolete test requirements can be found in SAE J183.

2.1 ASTM Standards:³

{Insert at the appropriate position: no other changes to this section. Several items in the list are not in ascending numerical order; this will be corrected before a new version of the Standard is issued.}

D8350 Test Method for Evaluation of Automotive Engine Oils in the Sequence IVB Spark-Ignition Engine

3.1.2 *category*, *n*—*in engine oils*, a designation such as SJ, SL, SM, SN, SP, CH-4, CI-4, CJ-4, CK-4, FA-4, Energy Conserving, Resource Conserving, and so forth, for a given level of performance in specified engine and bench tests.

4.1.1.2 Test Method D5533, the Sequence IIIE gasoline engine test, has been correlated with vehicles used in high-temperature service prior to 1988, ⁹ particularly with regard to oil thickening and valve train wear. (Alternatives are Test Method D6984, the Sequence IIIF test, or Test Method D7320, the Sequence IIIG test, or Test Method D8111, the Sequence IIIH test using Appendix X5 IIIH70 hour guidelines.)

4.1.1.3 Test Method D5302, the Sequence VE gasoline engine test, has been correlated with vehicles used in stop-and-go service prior to 1988, ¹⁰ particularly with regard to sludge and valve train wear. (Alternatives are the combination of Test Method D6593, the Sequence VG test, and Test Method D6891, the Sequence IVA test or the combination of Test Method D8256, the Sequence VH Test and Test Method D6891, the Sequence IVA test.)

4.1.2.1 Test Method D6984, the Sequence IIIF gasoline engine test, is used to measure oil thickening and piston deposits under high temperature conditions and provides information about valve train wear.¹¹ (Alternatives are, Test Method D7320, the Sequence IIIG test, or Test Method D8111, the Sequence IIIH test using Appendix X5 IIIH70 hour guidelines.)

4.1.2.4 Test Method D6593, the Sequence VG gasoline engine test, has been correlated with the Sequence VE gasoline engine test and with vehicles used in stop-and-go service prior to 2000, with regard to sludge and varnish deposit control. (An alternative is Test Method D8256, the Sequence VH Test.)

4.1.3.7 Test Method D6984, the Sequence IIIF test, is used to measure bulk oil viscosity increase, which indicates an oil's ability to withstand the higher temperatures found in modern diesel engines. (Alternatives are, Test Method D7320, the Sequence IIIG test, or Test Method D8111, the Sequence IIIH test using Appendix X4 IIIH60 guideline).

4.1.4.5 Test Method D6984, the Sequence IIIF gasoline engine test, is used to measure oil thickening under high temperature conditions in spark-ignition engines. (Alternatives are Test Method D7320, the Sequence IIIG test, or Test Method D8111, the Sequence IIIH test using Appendix X5 IIIH70 guideline or the Footnote F 60-80 h value).

4.1.5.7 Test Method D6984, the Sequence IIIF test, is used to measure bulk oil viscosity increase, which indicates an oil's ability to withstand the higher temperatures found in modern diesel engines. (Alternatives are Test Method D7320, the Sequence IIIG test, or Test Method D8111, the Sequence IIIH test using Appendix X5 IIIH70 guideline or the Footnote C 60-80 h value).

TABLE 1 S Engine Oil Categories

Required Test Method	Engine Test Method	T	Rated or Measured Parameter		Primarv	Performance Criteria	
Sequence IID (D5844 ^{A,B}) or	D5844	Average e	ngine rust rating, ^{c} min		1 mary	8.5	
D6557 ^A (Ball Rust Test)		Number st	uck lifters			none	
	D6557	Average gi	ray value, min			100	
		Hours to 3	75 % kinematic viscosity increase at 40 °C	, min		64	
		Average pi	iston skirt varnish rating $^{\circ}$ min			8.9	
		Average p	il ring land deposit rating. ^C min			3.5	
		Lifter sticki	ing			none	
	D5533	Scuffing ar	nd wear				
		Cam or lif	fter scuffing			none	
		Cam plus	lifter wear, μm Average, max			30	
			Maximum, max			64	
Sequence IIIE (D55335 ^D) or Sequence IIIF (D6984 ^D) or		Ring sticki	ng (oil-related) ^E			none	
Sequence IIIG (D7320 ^J) Sequence IIIH (D8111 ^{AE} using		Kinematic	viscosity, % increase at 40 °C, max			325'	
Appendix X5 IIIH70 hour	D6984	Weighted i	piston deposit rating H min			3.2 ⁶	
Juideline)	20001	Screened	average cam-plus–lifter wear, µm, max			20 ^{G,/}	
		Hot stuck r	ings			none ^G	
		Kinematic	viscosity, % increase at 40 °C, max			150	
	D7320	Weighted p	piston deposit rating, ^K min			3.5	
	D7320	Cam-plus-	lifter wear avg, μm, max			60	
		Hot stuck r	ings			none	
	D8111(Using	60 h kinem	natic viscosity, % increase at 40 °C, max			307	
	Appendix X5 IIIH70 hou guideline)	r 70 h avera	ge weighted piston deposits," merits, min			2.5	
			ge piston skin varnish,* ments, min			9.0	
		Rocker arr	n cover sludge rating. ^C min			7.0	
		Average pi	iston skirt varnish rating, ^C min			6.5	
		Average e	ngine varnish rating, ^c min			5.0	
	D5302	Oil ring clo	gging, %			report	
		Oil screen	clogging, %, max			20.0	
		Compressi	ion ring sticking (hot stuck)			none	
		Cam wear,	, μm Average, max			127	
Sequence VE (D5302 ^{B,L})	D6801	Average of			380		
or Sequence IVA (D6891 ^L) plus	D0091	Average e	ngine sludge rating ^c min		7.8		
Sequence IVA (D6891 ^L) plus		Rocker arr	Irm cover sludge rating, ^c min			8.0	
Sequence VH (D8256 ²)		Average pi	iston skirt varnish rating, ^c min		7.5		
	D6593	Average e	ngine varnish rating, ^N min			8.9	
		Oil screen	clogging, %, max			20	
		Hot stuck of	compression rings			none	
		Average er	ngine sludge, merits, min			7.4	
		Average ro	ocker cover sludge, merits, min			7.4	
	D8256	Average e	ngine varnish, merits, min			8.0 7.4	
		Oil screen	clogging, % area		F	Rate & Report	
		Hot stuck of	compression rings			None	
	DELLO	Bearing we	eight loss, mg, max			40	
L-38 (<mark>D5119⁰)</mark>	D5119	Shear stab	vility			Р	
or Sequece VIII (D6709 ⁰)	D6709	Bearing we	eight loss, mg, max			26.4	
	20103	Shear stab	bility			Р	
			Viscosity Grad	le Performance	e Criteria		
Bench Test and	Measured Parameter		SAE 0W-20,				
			SAE 5W-20,			All Others	
Test Method D4692 D4741 DE49	1 high tomporaturo/high a	boor	SAE 10W-30			2.6	
viscosity @ 150 °C, mPa·s, min	, nigh temperature/nigh s	alleal				2.0	
Test Method D5800 volatility loss,	% max ^R		22			20 ^{\$}	
Test Method D6417 volatility loss	at 371 °C, % max ^R		17			15 ^s	
Test Method D5480 volatility loss	at 371 °C, % max ^R		17			15 ^s	
Test Method <mark>D6795</mark> (EOFT), % flo	w reduction, max		50			50	
			with 0.6 % H ₂ 0	repo	rt	report	
Test Method D6794 (EOWTT). %	flow reduction, max		with 1.0 % H ₂ 0	repo	rt	report	
			with 2.0 % H ₂ 0	repo	rt	report	
			with 3.0 % H ₂ 0	repo	rt	report	
rest Method D4951 or D5185, ma	ss traction phosphorus, %	, max	0.10'			NR ^v	
(unless valid passing Test Metho	d <mark>D5302</mark> results are obtain	, min ied)	0.06			0.06	
Test Method D92 flash point, °C, r	nin ^v		200			NR ^U	
Test Methods D93 or D7094 flash	point, °C, min [∨]		185			NR ^U	
			Sequence I, max, foaming/settling ^w	10/0	D	10/0	
Test Method D892 foaming tender	ncy (Option A)		Sequence II, max, foaming/settling ^w	50/0	0	50/0	
			Sequence III, max, foaming/settling ^w	10/0)	10/0	
Test Method D6082 (optional blen endency/stability	ding required) Static foam,	max,		200/5	50×	200/50 [×]	
est Method D6922 homogeneity	and miscibility			Y		Ŷ	
est iviethod D6335 High tempera nass, mg, max	ure deposits (TEOST 33),	aeposit		60		60	
Test Method D5133 Gelation Inde	x. max			12		NR ^U	

Table 1 S Engine Oil Categories Continued

			API SL Category				
Required Test Method	Engine Test Method		Rated or Measured Parameter		Primary Pe	rformance Criteria	
		Kinematic visc	osity, % increase at 40 °C, max			275	
		Average pistor	n skirt varnish rating, ^c min			9.0	
	Deedd	Weighted pisto	on deposit rating, ^H min			4.0	
	D6984	Screened aver	rage cam-plus-lifter wear, μm, max			20′	
		Hot Stuck Ring	gs			none	
Sequence IIIF (D6984)		Low temperate	ure viscosity performance ^z			report	
or Sequence IIIG (D7320 ^J)		Kinematic visc	osity, % increase at 40 °C, max			150	
or Sequence IIIH (D8111 ^{AE} using Appendix X5 IIIH70 hour		Weighted pisto	on deposit rating, ^K min			3.5	
guideline)	D7320	Cam-plus-lifter	r wear avg, μm, max			60	
		Hot stuck rings	6			none	
		Low temperatu	ure viscosity performance ⁴⁴			report	
	D8111 (Using	70 h kinematio	viscosity, % increase at 40 °C, max			181	
	Appendix X5	70 h average v	veighted piston deposits, merits, min			3.3	
	guideline)	70 h average p	piston skirt varnish, ^c merits, min			7.9	
Sequence IVA (D6891)	D6891	Cam wear ave	erage, µm, ^M max			120	
Sequence VE (D5302 ^{AB,J})		Cam wear ave	erage, μm, max			127	
, ,	D5302	Cam wear ma	x, µm, max			380	
		Average engin	e sludge rating, ^c min			7.8	
		Rocker arm co	over sludge rating. ^C min			8.0	
		Average pistor	n skirt varnish rating. ^C min			7.5	
		Average engin	e varnish rating ^N min			8.9	
	D6593	Oil screen cloc	aging % max			20	
	20000	Hot stuck Corr	poression rings			20	
		Cold stuck ring	19.000.011 11190	n		report	
Sequence VG (D6593) or		Oil screen deb	ys nrie %			report	
Sequence VH (D8256)		Oil ring cloggir	no, %	report		report	
			ng, 70 Ne sludge merits min			7.4	
		Average rocke	er cover sludge, ments, min			7.4	
			e varnish merits min			8.6	
	D8256	Average pistor	n skirt varnish, merits, min			7.4	
		Oil screen clor	nging % area		Rat	e & Report	
		Hot stuck com	pression rings			None	
		Bearing weigh	t loss ma max			26.4	
Sequence VIII (D6709)	D6709	Shear stability				P	
		onour olability		Viscosity Grade P	Performance Crite	ria	
				SAE 0	W-20	All Others	
	Bench Test and M	leasured Paran	neter	SAE 5	W-20		
				SAE 5 SAE 10	0W-30 0W-30		
Test Method D4683, D4741, or [D5481, high temper	rature/high shea	r viscosity @ 150 °C, mPa⋅s, min	G)	2.6	
Test Method D6557 (Ball Rust T	est), average gray	value, min		10	0	100	
Test Method D5800 volatility los	s, % max			1:	5	15	
Test Method D6417 volatility los	s at 371 °C, % max			10	0	10	
D6795 (EOFT), % flow reduction	i, max			50	0	50	
			With 0.6 % H ₂ O	50	0	50	
D6794 (EOWTT), % flow reducti	on, max		With 1.0 % H ₂ O	50	0	50	
			With 2.0 % H ₂ O	50	0	50	
Test Method D4054 D5105		home 0/	vvitn 3.0 % H ₂ O	50		50	
Test Method D4951 or D5185, m	lass fraction phosp	horus %, max		0.1	U.		
(unless valid passing Test Meth	nod D5302 results a	are obtained) ^J		0.0	JU .	υ.υσ	
			Sequence I, max, foaming/settling ^w	10	/0	10/0	
Test Method D892 foaming tend	ency (Option A)		Sequence II, max, foaming/settling ^w	50	0/0	50/0	
			Sequence III, max, foaming/settling ^w	10.	/0	10/0	
Test Method D6082 (optional ble	ending required) sta	atic foam max, te	endency/stability	100	/0 [×]	100/0 [×]	
Test Method D6922 homogeneit	y and miscibility			Ŷ	·	Y	
Test Method D7097 high temper	ature deposits (TE	OST MHT-4), de	eposit mass, mg, max	4	5	45	
Test Method D5133 (Gelation In	dex), max ^{AC}			12	AD	12 ^{AD}	

^A Demonstrate passing performance in either Test Method D5844 or D6557.

^B Monitoring of this test method was discontinued in June 20, 2001. Valid test results shall predate the end of the last calibration period for the test stand in which this test method was conducted.

^c ASTM Deposit Rating Manual 20, available from ASTM Customer Relations, ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

^b Demostrate passing performance in either Test Method D5533 or D6984. However, an oil passing Test Method D6984 and containing less than 0.08 % mass phosphorus in the form of ZDDP shall also pass the wear limits in Test Method D5302 (see also footnote ⁴).

^E An oil-related stuck ring occurs on a piston with an individual oil ring land deposit rating <2.6.

^F Determine at 60 h.

^G Determine at 80 h.

^{*H*} Determine weighted piston deposits by rating the following piston areas and applying the corresponding weightings: undercrown, 10 %; second land, 15 %; third land, 30 %; piston skirt, 10 %; first groove, 5 %; second groove, 10 %; and third groove, 20 %. Use ASTM Deposit Rating Manual 20 for all ratings.

¹ Calculate by eliminating the highest and lowest cam-plus-lifter wear results and then calculating an average based on the remaining ten rating positions. ^J For oils containing at least 0.06 % mass phosphorus in the form of ZDDP, demonstrating passing performance in the Sequence IIIG test obviates the need to also conduct Test Method D5302 (Sequence VE), which was previously required for oils with less than 0.08 % mass phosphorus.

^K Unlike the Sequence IIIF test, piston skirt varnish rating is not required in the Sequence IIIG test.

^L Demonstrate passing performance in Test Method D5302, or alternatively, in both Test Method D6891 and Test Method D6593, or alternatively, in both Test Method D6891 and Test Method D8256.

^M Determine cam wear according to Test Method D6891. Seven wear measurements are made on each cam lobe and the seven measured values are added to obtain an individual cam lobe wear result. The overall cam wear value is the average of the twelve individual cam lobe wear results.

^N Determine the average engine varnish rating by averaging the piston skirt, right rocker arm cover, and left rocker arm cover varnish ratings. Use ASTM Deposit Rating Manual 20 for all ratings.

^o Demonstrate passing performance in either Test Method D5119 or D6709.

^P Ten-hour stripped kinematic viscosity (oil shall remain in original viscosity grade).

^o Minimum high temperature/high shear viscosity @ 150 °C for these viscosity grades as defined in SAE J300.

^R Meet the volatility requirement in either Test Method D5800, D5480, or D6417.

^s Passing volatility loss only required for SAE 15W-40 oils.

 T This is a noncritical specification as described in Practice D3244.

^U NR stands for Not Required.

^v Meet either Test Methods D92, D93, or D7094 flash point requirement.

^{*w*} Determine settling volume, in mL, at 10 min.

 x Determine settling volume, in mL, at 1 min.

^Y Homogeneous with SAE reference oils.

^Z Evaluate the 80 h test oil sample by Test Method D4684 at the temperature indicated by the low temperature grade of oil as determined on the 80 h sample by Test Method D5293

^{AA} Measure the viscosity of the EOT oil sample by Test Method D4684. The measured viscosity shall meet the requirements of the original grade or the next higher grade. The EOT sample can be either from a Sequence IIIG or a Sequence IIIGA test. (A Sequence IIIGA test is identical to a Sequence IIIG test, except only low temperature viscosity performance is measured.) Additional details are provided in the Sequence IIIG test method, in Section 13.6.

^{AB} Not required for oils containing a minimum of 0.08 % mass phosphorus in the form of ZDDP.

AC Requirement applies only to SAE 0W-20, 5W-20, 0W-30, 5W-30, and 10W-30 viscosity grades.

^{AD} For gelation temperatures at or above the W grade pumpability temperature as defined in SAE J300.

AE Alternatively, Test Method D8111 (Sequence IIIH) at 90 hours, passing at the API SM level of performance can be used to meet this requirement.

Required Test Method	Test Method	Rated o	r Measured Parameter	Prima	ry Performanc	e Criteria
				One-test	Two-test ^A	Three-test ^A
		Weighted demerits (WDP), max	350	378	390
		Top groove carbon (TGC)	, demerits, max	36	39	41
1P (D6681 ^B)	D6681	Top land carbon (TLC), de	emerits, max	40	46	49
	20001	Average Oil Consumption	, g/h (0 h – 360 h), max	12.4	12.4	12.4
		Final Oil Consumption, g/	h (312 h – 360 h), max	14.6	14.6	14.6
		Piston, ring, and liner scut	ffing	none	none	none ^C
		Weighted demerits (WDK), %, max	332	347	353
		Top groove fill (TGF), %,	max	24	27	29
1K (D6750 ^D)	D6750	Top land heavy carbon (T	LHC), %, max	4	5	5
		Average Oil	g/kWh (0 h – 252 h), max	0.54	0.54	0.54
		Consumption	g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scut	ffing	none	none	none ^c
		Average Liner Wear, norn	nalized to 1.75 % soot, μm max	25.4	26.6	27.1
	D6483	Average Top Ring Mass L	Loss, mg max ^E	120	136	144
		EOT Used Oil Lead Conte Content, mg/kg, max	ent less New Oil Lead	25	32	36
T-9 (D6483) or		Liner wear, µm, max		32	34	35
T-10 (D6987/D6987M)	D6987/D6987M	Ring wear, mg, max		150	159	163
or T-12 (<mark>D7422</mark>)		Lead content at EOT, mg/	/kg, max	50	56	59
		Liner wear, µm, max		30.0	30.8	31.1
	D7422	Top Ring Mass Loss, mg,	max	120	132	137
		Lead content at EOT, mg/	/kg, max	65	75	79
	25000		mils, max	0.30	0.33	0.36
RFWT (D5966)	D5966	Average Pin Wear	(μm) max	(7.6)	(8.4)	(9.1)
		Rocker Pad Average Mas mg max	s Loss, normalized to 4.5 % soot,	6.5	7.5	8.0
	D6838	Oil Filter Differential Press	sure at EOT, kPa max	79	93	100
M11 (D6838') or		Average Engine Sludge, 0	CRC Merits at EOT, min	8.7	8.6	8.5
ISM (<mark>D7468</mark>)		Crosshead wear, mg, ma	x	7.5	7.8	7.9
	D7468	Oil filter delta pressure, at	: 150 h, kPa, max	79	95	103
		Sludge rating, CRC merits	s, min	8.1	8.0	8.0
Ext. T-8E (D5967 ^G)	D5967	Relative Viscosity at 4.8 %	6 Soot by TGA, max	2.1	2.2	2.3
	20001	Viscosity increase at 3.8 %	% Soot by TGA, mm²/s, max	11.5	12.5	13.0
Sequence IIIF (D6984)	D6984	60 h Viscosity at 40 °C, in	crease from 10 min sample, % max	295	295 (MTAC)	⁴ 295 (MTAC) ^H
Sequence IIIG (D7320')	D7320	Kinematic viscosity, % inc	rease at 40 °C max	150	150 (MTAC)	150 (MTAC)
or Sequence IIIH (<mark>D8111</mark> using IIIH60 Appendix X4)	D8111 (IIIH60 Appendix X4)	60 h Kinematic viscosity, ^o	% increase at 40 °C max	249	249 (MTAC)	249 (MTAC)
EOAT (<mark>D6894</mark> ^J)	D6894	Aeration, volume, % max		8.0	8.0 (MTAC)	8.0 (MTAC) ^H
CH-4 Ber	nch Tests	Mea	asured Parameter	Prima	ry Performanc	e Criteria
		Used Oil Elemental Conce	entration			
		Copper, mg/kg increase, i	max		20	
HTCBT, 135 °C (D6594)	D6594	Lead, mg/kg increase, ma	ах		120	
		Tin, mg/kg increase			report	
		Copper strip rating, [^] max			3	<u></u>
		Foaming/Settling, ² mL, ma	ax		40/0	
D892 (Option A not allowed)	D892 (Option A not allowed)	Sequence I			20/0	
,		Sequence III			10/0	
		sequence in		SAE 10W	/-30	SAE 15W-40
Noack (<mark>D5800</mark>) or	D5800	percent volatility loss at 2	50 °C, max	20		18
D6417	D6417	percent volatility loss at 3	71 °C, max	17		15
				SAE XW	-30	SAE XW-40
D6278	D6278	Kinematic Viscosity after s	shearing, mm²/s at 100 °C, min	9.3		12.5

TABLE 2 Diesel Engine Oil Category CH-4

^A See Annex A3 for additional information.

^B Refer to RR:D02-1441.

^c If three or more operationally valid tests have been run, the majority of these tests shall not have scuffing. The scuffed tests are considered uninterpretable, and all data from these tests are eliminated from averaging.

^D Refer to RR:D02-1273.

^E Refer to RR:D02-1440.

F Refer to RR:D02-1439.

^c A passing T-11 (TGA % soot at 12.0 mm²/s increase, at 100 °C, min)—6.00 (first test), 5.89 (second test), and 5.85 (third test)—can be used in place of a T-8E in the applicable categories. This is not intended to indicate equivalence.

^{*H*} See Annex A2; use method without transformations.

^{*I*} The Sequence IIIG limits shown are more restrictive than the corresponding limits in Sequence IIIF, and are not intended to indicate equivalence. Results meeting the Sequence IIIG criteria stated can be used in lieu of Sequence IIIF.

^J Refer to RR:D02-1379.

^{κ} The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594. ^L Ten minutes for Sequence I, II, and III.

TABLE 3 Diesel Engine Oil Category CI-4

Required Test Method	Engine Test Method	F	Rated or Measu	red Parameter	Primary	Performance Cr	iteria
					One-test	Two-test ⁴	Three-test ^A
		Weighted demerits	(WDR), max		382	396	402
		Top groove carbon	(TGC), demeri	ts, max	52	57	59
		Top land carbon (T	LC), demerits,	max	31	35	36
	D6923	Initial oil consumpti	ion (IOC), (0 h -	- 252 h), g/h, average	13.1	13.1	13.1
		Final oil consumpti	on,(432 h – 504	h), g/h, average, max	IOC + 1.8	IOC + 1.8	IOC + 1.8
1P (D6023)		Piston, ring, and lin	er distress		none	none	none
or		Ring sticking			none	none	none
1P (<mark>D668</mark> 1)		Weighted demerits	(WDP), max		350	378	390
		Top groove carbon	(TGC), demeri	ts, max	36	39	41
		Top land carbon (T	LC), demerits,	max	40	46	49
	D6681	Average oil consun	nption, g/h (0 h	– 360 h), max	12.4	12.4	12.4
		Final oil consumpti	on. a/h (312 h -	· 360 h). max	14.6	14.6	14.6
		Piston ring and lin	er scuffing		none	none	none
T-10	D6987/D6987M	Merit rating ^A min	ior ocumig		1000	1000	1000
(D6987/D6987M)	D7422	Merit rating, min			1000	1000	1000
or T-12 (<mark>D7422</mark>)	01422	Mentrating, min			1000	1000	1000
		Average crosshead	l mass. loss, m	g, max	20.0	21.8	22.6
	D6975	Average top ring m	ass loss, mg		report	report	report
M11 EGR (D6975)		Oil filter differential	pressure at 25	0 h, kPa, max	275	320	341
or		Average engine slu	idge, CRC mer	its at EOT, min	7.8	7.6	7.5
ISM (D7468)		Crosshead wear, m	ng, max		7.5	7.8	7.9
	D7468	Oil filter ∆ pressure	e at 150 h, kPa,	max	55	67	74
		Sludge rating, CRC	C Merits, min		8.1	8.0	8.0
Ext. T-8E (D5967) ^B	D5967	Relative viscosity a	at 4.8 % soot ^c		1.8	1.9	2.0
Sequence IIIF	D6984	Kinematic viscosity	(at 40 °C), per	cent increase, max	275	275 (MTAC)	275 (MTAC)
(D6984) ^D	D7320	Kinematic viscosity	, percent increa	ase at 40 °C max	150	150 (MTAC)	150 (MTAC)
Sequence IIIG	D8111	60−80 h ^F Kinemat	ic viscosity, % i	ncrease at 40 °C max	370	370 (MTAC)	370 (MTAC)
or Sequence IIIH (D8111) or Sequence IIIH70 (D8111 using Appendix X5)	D8111 (Using IIIH70 Appendix X5 guideline)	70 h Kinematic viso	cosity, % increa	se at 40 °C max	181	181 (MTAC)	181 (MTAC)
, pp on an () ()		Weighted demerits	(WDK), max		332	347	353
		Top groove fill (TG	F), %, max		24	27	29
	Darra	Top land heavy car	bon (TLHC), %	, max	4	5	5
1K (D6750) ⁹	D6750			g/kWh (0 h – 252 h), max	0.54	0.54	0.54
		Average oil consun	nption	g/MJ (0 h <i>-</i> 252 h), max	0.15	0.15	0.15
		Piston, ring, and lin	er scuffing		none	none	none
				mils, max	0.30	0.33	0.36
RFWT (<mark>D5966</mark>)	D5966	Average pin wear		µm, max	7.6	8.4	9.1
EOAT (<mark>D6894</mark>) ^H	D6894	Aeration, volume p	ercent, max	, , , , , , , , , , , , , , , , , , ,	8.0	8.0 (MTAC) [/]	8.0 (MTAC) [/]
		, ,	,				
	CI-4 Bench Tests			Measured Parameter		Primary Perfor	mance Criteria
D4683 or D4741 o	CI-4 Bench Tests or D5481 ^J		High temperat	Measured Parameter ure/high shear viscosity at 150 °	°C ^k , min	Primary Perfor 3.5 m	mance Criteria Pa-s
D4683 or D4741 o MRV-TP-1 (D4684	CI-4 Bench Tests or D5481 ^J		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used –20 °C, mPa-s	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- s, max	°C [≽] , min ity grades 0W, 5W, st (or T-10A [⊥] test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 d	mance Criteria IPa-s
D4683 or D4741 c MRV-TP-1 (D4684	CI-4 Bench Tests or D5481 ^J		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi y: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max	'C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (mance Criteria nPa-s 000 000
D4683 or D4741 c MRV-TP-1 (D4684	CI-4 Bench Tests or D5481 ⁷ 4)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- 5, max is detected, use modified nal preheat), then mPa-s, max is, Pa use at 250 °C % max	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (mance Criteria IPa-s 000 000 35
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800)	CI-4 Bench Tests or D5481 ^J		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, ma/kd	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- 5, max is detected, use modified nal preheat), then mPa-s, max ss, Pa uss at 250 °C, %, max a increase, max	[•] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 2 2 2 2 2 2 2 2 2 2 2 2 2	mance Criteria IPa-s 000 000 35 5 0
D4683 or D4741 c MRV-TP-1 (D4684 Noack (D5800)	CI-4 Bench Tests or D5481 ^J 4)		High temperat The following 10W, and 15V Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg in	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max iss at 250 °C, %, max g increase, max	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 2 1 1 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1	mance Criteria 1Pa-s 000 000 35 5 0 20
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D	CI-4 Bench Tests or D5481 ^J 4) 6594)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg in Tin, mg/kg inc	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max iss, Pa uss at 250 °C, %, max g increase, max necrease, max rease	[•] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 2 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 1 2 2 1 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2	mance Criteria nPa-s 0000 000 35 5 0 20 20 port
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D	CI-4 Bench Tests pr D5481 ⁷ 4) 6594)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg inc Tin, mg/kg inc Copper strip ra	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max ss, Pa iss at 250 °C, %, max g increase, max ncrease, max rease ating, ⁰ max	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 2 1 2 1 2 1 2 3 3 3 3 3 3 3 3 4 3 4 3 5 4 3 5 4 3 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	mance Criteria nPa-s 000 000 35 5 0 20 20 20 20 20 3
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D D6278	CI-4 Bench Tests pr D5481 ⁷ 4) 6594)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg inc Copper strip ra Kinematic visc mm ² /s at 100	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosity is hused oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max is at 250 °C, %, max g increase, max ncrease, max ncrease, max ncrease, max cosity after shearing °C, min	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 2 12 12 12 12 5AE XW-30 9.3	mance Criteria IPa-s 000 000 000 000 000 000 000 0
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D D6278	CI-4 Bench Tests or D5481 ^J 4) 6594)		High temperat The following 10W, and 15V Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg in Tin, mg/kg inc Copper strip ra Kinematic visc mm ² /s at 100 Foaming/settli	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosity to she used oil sample from T-10 te oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max is sat 250 °C, %, max g increase, max norease, max rease ating, ^o max cosity after shearing °C, min ng, ^p mL, max_	² C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (2	mance Criteria IPa-s 000 000 000 000 000 000 000 0
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D D6278	CI-4 Bench Tests pr D5481 ^J 4) 6594)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg in Tin, mg/kg inc Copper strip ra Kinematic visc mm ² /s at 100 Foaming/settli Sequence I	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosi V: 5 h used oil sample from T-10 te oil sample from T-12 test (or T- 5, max is detected, use modified nal preheat), then mPa-s, max is detected, use modified nal preheat), then mPa-s, max is at 250 °C, %, max g increase, max ncrease ating, ° max cosity after shearing °C, min ng, ^P mL, max	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (2	mance Criteria IPa-s 000 000 000 000 000 000 000 0
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D D6278 D892 (Option A no	CI-4 Bench Tests pr D5481 ³ 4) 6594) bt allowed)		High temperat The following 10W, and 15W Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress i D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg inc Copper strip ra Kinematic visc mm ² /s at 100 Foaming/settli Sequence I Sequence II	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosity is hused oil sample from T-10 ter oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max is at 250 °C, %, max g increase, max ncrease ating, ⁰ max cosity after shearing °C, min ng, ^P mL, max	[°] C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 (25 (25 (1 25 (1 2 12 12 12 12 12 5AE XW-30 9.3 10 20 20 20 20 20 20 20 20 20 2	mance Criteria IPa-s 000 000 000 000 000 000 000 0
D4683 or D4741 o MRV-TP-1 (D4684 Noack (D5800) 135 °C HTCBT (D D6278 D892 (Option A no	CI-4 Bench Tests pr D5481 ³ 4) 6594) bt allowed)		High temperat The following 10W, and 15V Viscosity of 75 or 100 h used -20 °C, mPa-s If yield stress D4684 ^N (exter and yield stress Evaporative lo Copper, mg/kg Lead, mg/kg inc Copper strip ra Kinematic visc mm ² /s at 100 Foaming/settli Sequence I Sequence III	Measured Parameter ure/high shear viscosity at 150 ° limits are applied to SAE viscosity is hused oil sample from T-10 ter oil sample from T-12 test (or T- s, max is detected, use modified nal preheat), then mPa-s, max is a detected, use modified nal preheat), then mPa-s, max ss, Pa iss at 250 °C, %, max g increase, max ncrease, max ncrease, max rease ating, ° max posity after shearing °C, min ng, ^P mL, max	² C ^k , min ity grades 0W, 5W, st (or T-10A ^L test), 12A ^M test, tested at	Primary Perfor 3.5 m 25 0 25 0 25 0 25 0 25 0 12 12 12 12 12 12 12 12 12 12	mance Criteria IPa-s 000 000 000 000 000 000 000 0

Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5, -3)	(+7, -5)	(+10, -TMC 1006)	(+10, -TMC 1006)
Silicone (VMQ)	(+TMC 1006, -3)	(+5, -TMC 1006)	(+10, -45)	(+20, -30)
Polyacrylate (ACM)	(+5, -3)	(+8, -5)	(+18, -15)	(+10, -35)
Fluoroelastomer (FKM)	(+5, -2)	(+7, -5)	(+10, -TMC 1006)	(+10, -TMC 1006)
Note TMC 1006 is the des	ignation for the reference oil used	in this test method. This designat	ion represents the original bland o	or subsequent approved to blends

for the reference oli used in this test method. This de on represents the original b sigi of TMC 1006.

^A See Annex A4 for additional information.

^B A passing T-11 (TGA % soot at 12.0 mm²/s increase, at 100 °C, min)—6.00 (first test), 5.89 (second test), and 5.85 (third test)—can be used in place of a T-8E in the applicable categories. This is not intended to indicate equivalence.

^c Relative Viscosity (RV) = viscosity at 4.8 % soot/viscosity of new oil sheared in Test Method D6278.

^D Refer to RR:D02-1391.

^E The Sequence IIIG limits shown are more restrictive than the corresponding limits in Sequence IIIF, and are not intended to indicate equivalence. Results meeting the Sequence IIIG criteria stated can be used in lieu of Sequence IIIF.

$$PVIS@(60 - 80)h = \left(\frac{\sqrt{PVIS@60 h} + \sqrt{PVIS@80 h}}{2}\right)^2$$
, where PVIS@60 h is

^F 60 – 80 h value is interpolated according to the equation percent viscosity increase at 60 h and PVIS@80 h is percent viscosity increase at 80 h.
 ^G Refer to RR:D02-1273. Alternatively, Test Method D6750 (1N) can be used; if this test method is used, the measured parameters and primary performance criteria are the same as those shown for Test Method D6750 (1N) in the CJ-4 category.

^H Refer to RR:D02-1379.

^{*I*} See Annex A2; use method without transformations.

^J Tests as allowed in SAE J300.

^{*K*} Noncritical specification as defined by Practice D3244; may be superseded only by applicable higher limits set by SAE J300. ^{*L*} The T-10A test is the name given to a T-10 test run for 75 h to generate the sample for measurement by Test Method D4684.

^M The T-12A test is the name given to a T-12 test run for 100 h to generate the sample for measurement by Test Method D4684.

^N Refer to RR:D02-1517.

 $^{\rm O}\,$ The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.

		TABLE 4	Diesel Engine Oil C	Categ	jory CJ-4				
Required Test Method	Engine Test Method		Rated or Measured Parar	meter		Primar	ry Perfor	mance C	riteria
						One-test	Tw	o-test	Three-test
T-12 (<mark>D7422</mark>)	D7422	Merit rating, ^A m	in			1000	1	000	1000
ISM (D7468)	D7468	Merit rating, ^A m	in			1000	1	000	1000
	27100	Top ring mass I	loss, mg, max			100	ŕ	100	100
C13 (D7549)	D7549	Merit rating, ^A m	in			1000	1	000	1000
	2.010	Hot-stuck pistor	n ring			none	n	one	none
		TGA % Soot at	4.0 mm ² /s increase, at 100) °C, m	in	3.5	;	3.4	3.3
T-11 (D7156)	D7156	TGA % Soot at	12.0 mm ² /s increase, at 10	00 °C, I	min	6.0	4	5.9	5.9
		TGA % Soot at	15.0 mm ² /s increase, at 10	00 °C, i	min	6.7	(6.6	6.5
		Slider tappet m	ass loss, mg, average, max	x		100	ŕ	108	112
ISB (D7484)	D7484	Cam lobe wear	, μm, average, max			55		59	61
		Crosshead mas	ss loss, mg, average			report	re	eport	report
		Weighted deme	erits (WDN), max			286.2	3	11.7	323.0
		Top groove fill ((IGF), %, max			20		23	25 F
		Top land neavy	carbon (TLHC), %, max	$\alpha/k M/k$	0 h 252 h)	0.54	0	4	5 0.54
1N (<mark>D6750</mark>)	D6750			max	1, (011–25211),	0.54	0	.34)	0.34
		Oil consumption	n	g/MJ	(0 h – 252 h),	0.15	C).15	0.15
				max					
		Piston, ring, an	d liner scuffing			none	n	one	none
		Piston ring stick	king	1		none	n	one	none
RFWT (<mark>D5966</mark>)	D5966	Average pin we	ear,	mils, ı	max	0.30	C	0.33	0.36
				μm, n	nax	(7.6)	(8.4)	(9.1)
Sequence IIIF (D6984) or	D6984	Kinematic visco	osity (at 40 °C), % increase,	, max		275	275 ((MTAC)	275 (MTAC)
Sequence IIIG (D7320) ^B	D7320	Kinematic visco	osity (at 40 °C), % increase,	, max	0	150	150 ((MTAC)	150 (MTAC)
or Sequence IIIH (<mark>D8111</mark>)	D8111	60 – 80 h ^v Kine	matic viscosity, % increase	at 40	°C max	370	370 ((MTAC)	370 (MTAC)
or	D8111(Using IIIH70								
(D8111 using Appendix X5)	Appendix X5 guideline)	70 h Kinematic	viscosity, % increase at 40	°C ma	IX	181	181 ((MTAC)	181 (MTAC)
EOAT (<mark>D6894</mark>)	D6894	Aeration, volum	ne, %, max			8.0	8.0 (MTAC)	8.0 (MTAC)
Rench Too	t Methods							0	
Denon Tes	(Mothodo		Measured Parameter	r		Primar	ry Perfor	mance C	riteria
D4683 or D4171 or D548	1	High temperatu	Measured Parameter re/high shear viscosity at 1	r <mark>50 °C,</mark>	min	Primar	ry Perfor 3.5 n	rmance C nPa-s	riteria
D4683 or D4171 or D548	1	<mark>High temperatu</mark> Copper, mg/kg	Measured Paramete rre/high shear viscosity at 1 increase, max	r <mark>50 °C,</mark>	min	Primai	ry Perfor 3.5 n 2	rmance C nPa-s 20	nteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594)	1	High temperatu Copper, mg/kg Lead, mg/kg ind	Measured Paramete re/high shear viscosity at 1 increase, max crease, max	r <mark>50 °C,</mark>	min	Primar	ry Perfor 3.5 n 2 12	rmance C nPa-s 20 20	riteria
D4683 or D4171 or D548	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat	Measured Parameter re/high shear viscosity at 1 increase, max crease, max ting, ^D max	r <mark>50 °C,</mark>	min	Primar	ry Perfor 3.5 n 2 12 12	rmance C nPa-s 20 20 3	nteria
D4683 or D4171 or D548	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco	Measured Paramete ire/high shear viscosity at 1 increase, max crease, max ting, ^D max psity after 90 pass shearing	r <mark>50 °C,</mark> , mm²/	min s at 100 °C,	Primar	ry Perfor 3.5 n 2 12 30	mance C nPa-s 20 20 3 SA	E XW-40
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip ral Kinematic visco min	Measured Paramete ire/high shear viscosity at 1 increase, max crease, max ting, ^D max psity after 90 pass shearing	r 50 °C, , mm²/	min s at 100 °C,	Primar SAE XW-3 9.3	ry Perfor 3.5 n 2 11 11 30	mance C nPa-s 20 3 SA	E XW-40 12.5
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min	Measured Parameter re/high shear viscosity at 1 increase, max crease, max ting, ^D max osity after 90 pass shearing as at 250 °C. % max	r 50 °C, , , mm²/	min s at 100 °C,	Primar SAE XW-3 9.3 SAE < > 10V	7y Perfor 3.5 n 2 12 30 30 V-30	nPa-s 20 20 3 SA	E XW-40 12.5 E 10W-30
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los	Measured Paramete re/high shear viscosity at 1 increase, max crease, max ting, ^D max psity after 90 pass shearing as at 250 °C, %, max	r 50 °C,	min 's at 100 °C,	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 12 30 V-30	nPa-s 20 20 3 SA SA	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin	Measured Parameter re/high shear viscosity at 1 increase, max crease, max ting, ^D max posity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max	r 50 °C, ∣, mm²/	min 's at 100 °C,	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 3.5 n 2 12 30 80 V-30	mance C nPa-s 20 3 SA SA	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I	Measured Paramete re/high shear viscosity at 1 increase, max crease, max ting, ⁰ max posity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max	r 50 °C, , mm²/	min 's at 100 °C,	Primar SAE XW-3 9.3 SAE <> 10V 13	7 Perfor 3.5 n 2 1: 30 V-30 10	nPa-s 20 20 3 SA SA	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II	Measured Paramete inc/high shear viscosity at 1 increase, max crease, max ting, ^D max posity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max	r 50 °C, , mm²/	min 's at 100 °C,	Primar SAE XW-3 9.3 SAE < > 10V 13	y Perfor 3.5 n 2 11 30 V-30 10 20 10 20	mance C nPa-s 20 20 3 SA SA SA 0/0	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence II	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing is at 250 °C, %, max g, ^E mL, max	r 50 °C,	min 's at 100 °C,	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 1: 30 V-30 10 20 10	mance C nPa-s 20 20 3 SA SA 0/0 0/0	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip ral Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C	Measured Paramete re/high shear viscosity at 1 increase, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max	r 50 °C, , mm²/	min 's at 100 °C, a T-11 test,	Primar SAE XW-3 9.3 SAE < > 10V 13	3.5 n 2 12 330 V-30 10 20 10 25	mance C nPa-s 20 20 3 SA SA SA 0/0 0/0 0/0 0/0	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence I Sequence II Viscosity of the tested at -20 °C If yield stress of	Measured Paramete re/high shear viscosity at 1 increase, max crease, max ting, ^D max posity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max e detected, use the modified at) then measure the visco	r 50 °C, , mm²/ le from d test n	min is at 100 °C, a T-11 test, nethod	Primar SAE XW-3 9.3 SAE <> 10V 13	V-30 10 10 12 12 12 12 12 12 10 10 25 25	mance C nPa-s 20 3 SA SA 0/0 0/0 0/0 0/0 0/0 0/0 000	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip ral Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at –20 °C If yield stress is (external prehe Measure the vis	Measured Paramete re/high shear viscosity at 1 increase, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max i detected, use the modified at), then measure the visco ald stress. Pa	r 50 °C, , mm²/ le from d test n ssity, n	min 's at 100 °C, 's a T-11 test, nethod IPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 12 330 V-30 10 20 10 25 25	mance C nPa-s 20 20 3 SA SA 0/0 0/0 0/0 0/0 000 35	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	1	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel	Measured Paramete re/high shear viscosity at 1 increase, max crease, max crease, max bosity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-crit	r 50 °C, , mm ² / le from d test n psity, n tical)	min 's at 100 °C, 'a T-11 test, nethod iPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 12 330 V-30 10 20 10 25 <	mance C nPa-s 20 20 3 SA SA 0/0 0/0 0/0 0/0 0/0 000 35	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes	1 1 t Methods	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at –20 °C If yield stress is (external prehe Measure the yiel	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max a detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-crit Measured Paramete	r 50 °C, , mm ² / le from d test n ssity, n tical) r	min 's at 100 °C, 'a T-11 test, nethod iPa-s, max	Primar SAE XW-3 9.3 SAE < > 10V 13	3.5 n 2 1: 30 V-30 10 20 10 25 25 <	mance C nPa-s 20 20 3 SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 000 35	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	t Methods	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, [£] mL, max 180 h used oil drain sampl C, mPa-s, max i detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-critt Measured Paramete ulfated ash, %, max	r 50 °C, , mm²/ le from d test n osity, n tical) r	min is at 100 °C, a T-11 test, nethod nPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 11 30 V-30 10 25 25	mance C nPa-s 20 20 3 SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	IE XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	t Methods	High temperatu Copper, mg/kg Lead, mg/kg inc Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction p	Measured Paramete re/high shear viscosity at 1 increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max i detected, use the modified at), then measure the visco at), then measure the visco eld stress, Pa Chemical Limits (non-criti Measured Paramete ulfated ash, %, max hosphorus, %, max	r 50 °C, , mm ² / le from d test n sity, n tical) r	min 's at 100 °C, 's a T-11 test, nethod IPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 12 330 V-30 10 25 25 7 25 7 25 7 25 7 7 7 7 7 7 1 0.	mance C nPa-s 20 20 3 SA SA 0/0 0/0 0/0 0/0 0/0 000 35 cmance C .0 12	riteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896)	t Methods	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip ral Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction s	Measured Paramete re/high shear viscosity at 1 increase, max crease, max crease, max bosity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-criti Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max	r 50 °C, , mm ² / le from d test n ssity, n tical) r	min 's at 100 °C, 's a T-11 test, nethod nPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	Image: symbol with the symbol withe symbol with the symbol with the symbol with the sym	mance C nPa-s 20 20 3 SA SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 000 35 cmance C .0 12 .4	riteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951	t Methods	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction s	Measured Paramete increase, max crease, max crease, max biting, ^D max posity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-criti Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compating)	r 50 °C, 1, mm ² / le from d test n psity, n tical) r tibility)	min 's at 100 °C, 'a T-11 test, nethod nPa-s, max	Primar SAE XW-3 9.3 SAE <> 10V 13	3.5 n 2 1: 30 V-30 10 25 <	mance C nPa-s 20 20 3 SA SA SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de	t Methods	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction p Mass fraction s	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-criti Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compal compatibility. Candidate oi	r 50 °C, 1, mm ² / le from d test n ssity, n tical) r tibility) Is shal	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod nPa-s, max	Primar SAE XW-3 9.3 SAE < > 10V 13 13 Primar	3.5 n 2 1: 30 V-30 10 20 10 20 10 20 10 25 79 Perfor 1 0. 0 ed special	mance C nPa-s 20 20 3 3 SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	IE XW-40 12.5 E 10W-30 15 riteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de	t Methods adjusted specification lim scribed in Annex A5. Volume C	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yield Mass fraction s Mass fraction p Mass fraction s	Measured Paramete increase, max crease, max crease, max crease, max increase, max crease, max crease, max crease, max crease, max soluty after 90 pass shearing as at 250 °C, %, max g, [£] mL, max g, [£] mL, max 180 h used oil drain sampl c, mPa-s, max i detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-criti Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compati compatibility. Candidate oi Hardness Change, Poir	r 50 °C, 1, mm ² / le from d test n sity, n tical) r tibility) r tibility)	min 's at 100 °C, 'a T-11 test, nethod IPa-s, max I, however, confo	Primar SAE XW-3 9.3 SAE < > 10V 13 Primar Primar	y Perfor 3.5 n 2 11 30 V-30 10 20 10 20 10 20 10 20 10 20 10 25 ry Perfor 1 0. 0 ed speci Elongai	mance C nPa-s 20 3 SA SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	nteria IE XW-40 12.5 E 10W-30 15 riteria nits, the eak Change, %
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de Elastomer Nitrile (NBR)	t Methods t Methods adjusted specification lim scribed in Annex A5. Volume C (+5, -3)	High temperatu Copper, mg/kg Lead, mg/kg inc Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction s Mass fraction s	Measured Paramete increase, max crease, max crease, max crease, max increase, max crease, max increase, max crease, max soluty after 90 pass shearing as at 250 °C, %, max g, [£] mL, max 180 h used oil drain sampl C, mPa-s, max is detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-critt Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compati compatibility. Candidate oi Hardness Change, Poir (+7, -5)	r 50 °C, , mm ² / le from tical) r tibility) r tibility)	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod Pa-s, max I, however, conford Tensile Streng (+10, -TMC 1000	Primar SAE XW-3 9.3 SAE <> 10V 13 	3.5 n 2 11: 30 V-30 V-30 V-30 10 20 20 20 10 20 20 20 20 20 20 20 20 20 2	mance C nPa-s 20 20 3 SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 000 35 mance C .0 12 .4 tion at Bree MC 1006	nteria E XW-40 12.5 E 10W-30 15
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de Elastomer Nitrile (NBR) Silicone (VMQ)	t Methods t Methods djusted specification lim scribed in Annex A5. Volume C (+5, -3) (+TMC 10063	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rat Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence I Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yie Mass fraction s Mass fraction s Mass fraction s its for elastomer hange, %	Measured Paramete re/high shear viscosity at 1 increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-critt Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compat compatibility. Candidate oi Hardness Change, Poir (+7, -5) (+5, -TMC 1006)	r 50 °C, 1, mm ² / le from d test n sisty, n tical) r tibility) ils shal	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod nPa-s, max I, however, confor Tensile Streng (+10, -TMC 1000 (+10, -45)	Primar SAE XW-3 9.3 SAE <> 10V 13 	y Perfor 3.5 n 2 12 330 V-30 10 20 10 25	mance C nPa-s 20 20 3 SA SA SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	E XW-40 12.5 E 10W-30 15 riteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de Elastomer Nitrile (NBR) Silicone (VMQ) Polyacrylate (ACM)	t Methods adjusted specification lim scribed in Annex A5. Volume C (+5, -3) (+TMC 1006, -3 (+5, -3)	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yie Mass fraction s Mass fraction s Mass fraction s its for elastomer hange, %	Measured Paramete re/high shear viscosity at 1 increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-crit Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compat compatibility. Candidate oi Hardness Change, Poir (+7, -5) (+5, -TMC 1006) (+8, -5)	r 50 °C, 1, mm ² / le from d test n bsity, n tical) r tibility) ls shal nts	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod nPa-s, max I, however, confor Tensile Streng (+10, -TMC 1000 (+10, -45) (+18, -15)	Primar SAE XW-3 9.3 SAE <> 10V 13 Primar Primar primar primar SAE SAE SAE SAE SAE SAE SAE SAE SAE SAE	3.5 n 2 11 30 V-30 10 25 4 25 4 25 4 10 25 4 10 25 4 10 25 4 10 25 4 10 25 4 10 10 10 11 11 12 13 14 15 16 17 17 10 10 10 11 11 12 13 14 15 16 17 17 17 <td< td=""><td>mance C nPa-s 20 20 3 SA 0/0 12 .4 ification lin ification at Bree TMC 1006 0/0 35</td><td>Iteria</td></td<>	mance C nPa-s 20 20 3 SA 0/0 12 .4 ification lin ification at Bree TMC 1006 0/0 35	Iteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de Elastomer Nitrile (NBR) Silicone (VMQ) Polyacrylate (ACM) Fluoroelastomer (FKM)	t Methods t Methods djusted specification lim scribed in Annex A5. Volume C (+5, -3) (+TMC 1006, -3 (+5, -3) (+5, -2)	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rai Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Sequence III Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction s Mass fraction s its for elastomer hange, %	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, ^E mL, max 180 h used oil drain sampl C, mPa-s, max detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-crit Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compal compatibility. Candidate oi Hardness Change, Poir (+7, -5) (+5, -TMC 1006) (+8, -5) (+7, -5)	r 50 °C, 1, mm ² / le from d test n bsity, n tical) r tibility) ls shal nts	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod nPa-s, max I, however, conford Tensile Streng (+10, -TMC 1000 (+10, -45) (+18, -15) (+10, -TMC 1000	Primar SAE XW-3 9.3 SAE < > 10V 13 Primar Primar prim to the <i>adjustr</i> th Change, % 3) 5)	3.5 n 2 3.5 n 2 1: 30 V-30 10 20 20 20 21: 30 V-30 10 20 25 26 27 28 29 20 21 22 23 <tr< td=""><td>Imance C nPa-s 20 20 3 SA 0/0 12 .4 ification lin ification at Bre 0/0 1/2 .4 If (0) 0/0 0/0 0/0 0/0 <t< td=""><td>Iteria</td></t<></td></tr<>	Imance C nPa-s 20 20 3 SA 0/0 12 .4 ification lin ification at Bre 0/0 1/2 .4 If (0) 0/0 0/0 0/0 0/0 <t< td=""><td>Iteria</td></t<>	Iteria
D4683 or D4171 or D548 HTCBT, 135 °C (D6594) D7109 Noack (D5800) Foam (D892) MRV TP-1 (D6896) Bench Tes D874 D4951 Note—These are the <i>una</i> calculation of which is de Elastomer Nitrile (NBR) Silicone (VMQ) Polyacrylate (ACM) Fluoroelastomer (FKM) Vamac G	t Methods adjusted specification lim scribed in Annex A5. Volume C (+5, -3) (+TMC 1006, -3 (+5, -2) (+TMC 1006, -3	High temperatu Copper, mg/kg Lead, mg/kg ind Copper strip rati Kinematic visco min Evaporative los Foaming/settlin Sequence I Sequence II Viscosity of the tested at -20 °C If yield stress is (external prehe Measure the yiel Mass fraction s Mass fraction p Mass fraction p Mass fraction s	Measured Paramete increase, max crease, max crease, max bity after 90 pass shearing as at 250 °C, %, max g, [£] mL, max 180 h used oil drain sampl c, mPa-s, max i detected, use the modified at), then measure the visco eld stress, Pa Chemical Limits (non-crit Measured Paramete ulfated ash, %, max hosphorus, %, max ulfur, %, max D7216 (Elastomer Compatibility. Candidate oi Hardness Change, Poir (+7, -5) (+5, -TMC 1006) (+8, -5) (+7, -5) (+5, -TMC 1006)	r 50 °C, , mm ² / le from d test n sity, n tibility) r tibility) r nts	min 's at 100 °C, 's at 100 °C, a T-11 test, nethod Pa-s, max I, however, confor Tensile Streng (+10, -TMC 1000 (+10, -45) (+18, -15) (+10, -TMC 1000 (+10, -TMC 1000)	Primai SAE XW-3 9.3 SAE <> 10V 13 Primai Primai prim to the <i>adjusti</i> th Change, % 5) 5)	y Perfor 3.5 n 2 11 30 V-30 10 20 10 20 10 20 10 20 10 20 10 20 10 25 ry Perfor 1 0. 0 ed speci Elongai (+10, -T (+20, -3) (+10, -T (+10, -T (+10, -T (+10, -T (+10, -T	mance C nPa-s 20 20 3 SA SA SA SA 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/0 0/	ILE XW-40 12.5 E 10W-30 15 riteria mits, the eak Change, %))

TABLE 4 Diesel Engine Oil Category C.I.4					
	TABLE 4	Diesel Er	naine Oil	Category	CJ-4

^A See Annex A6 for additional information.
 ^B The Sequence IIIG limits shown are more restrictive than the corresponding limits in Sequence IIIF, and are not intended to indicate equivalence. Results meeting the Sequence IIIG criteria stated can be used in lieu of Sequence IIIF.

$$PVIS@(60 - 80)h = \left(\frac{\sqrt{PVIS@60 h} + \sqrt{PVIS@80 h}}{2}\right)^{2}, \text{ where PVIS@60 h is percent viscosity increase at 60 h and PVIS@80 h is percent viscosity increase at 80 h.}$$
^{*c*} 60 - 80 h value is interpolated according to the equation percent viscosity increase at 80 h.
^{*p*} The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.
^{*c*} Ten minutes for Sequence I, II, and III.

Required Test Method	d Engir	ne Test Method		Rated or Measured Pa	arameter			Prim	ary Performanc	e Criteria
								One-test	Two-test ^A	Three-test ^A
T 12 (D7422)		D7400	Top Ring Mass	Loss, mg, max				105	105	105
1-12 (D7422)		D7422	Cylinder Liner \	Vear, μm, max				24.0	24.0	24.0
			IR Peak at EOT	Γ, Abs., cm ^{−1}				125	130	133
T-13 (<mark>D8048</mark>)		D8048	Kinematic Visco	osity Increase at 40 °C, %	6 max			75	85	90
			Avg. Oil Consu	mption, 48 h to 192 h, g/ł	n, max			Report	Report	Report
			TGA % Soot at	4.0 mm ² /s increase, at 1	00 °C, mi	in		3.5	3.4	3.3
T-11 (<mark>D7156</mark>)		D7156	TGA % Soot at	12.0 mm ² /s increase, at	100 °C, n	nin		6.0	5.9	5.9
			TGA % Soot at	15.0 mm ² /s increase, at	100 °C, n	nin		6.7	6.6	6.5
C13 (D7549)		D7549	Merit rating, ^A m	in				1000	1000	1000
COAT (D8047)		D8047	Average Aerati	on, ^A 40 h to 50 h, %				11.8	11.8	11.8
			Slider tappet m	ass loss, mg, average, m	ax			100	108	112
ISB (D7484)		D7484	Cam lobe wear	, μm, average, max				55	59	61
			Crosshead mas	ss loss, mg, average				Report	Report	Report
		57400	Top Ring Mass	Loss, mg, max				100	100	100
ISM (D7468)		D7468	Merit Rating, ^A					1000	1000	1000
			Weighted deme	erits (WDN), max				286.2	311.7	323.0
			Top groove fill ((TGF), %, max				20	23	25
			Top land heavy	v carbon (TLHC), %, max				3	4	5
1N (D6750)		D6750			g/kWh,	(0 h to	252 h),	0.54	0.54	0.54
		20700	Oil consumption	n	max					
					g/MJ (0) h to 2	52 h), max	0.15	0.15	0.15
			Piston, ring, and	d liner scutting				none	none	none
	_		Piston ring stick	king				none	none	none
RFWT (<mark>D5966</mark>)		D5966	Average pin we	ear,	miis, m	ax		(7.0)	0.33	0.36
				CK 4 Catagon / Dana	µm, ma	ax		(7.0)	(0.4)	(9.1)
Test Mathad			Maggurad	Deremeter	ii iesis			Drimen (D	orformanaa Crit	rie
			SAE 1300 Vic					20		
D4683				min			3.5	-00		
or	High tem	perature/high sh	near viscosity at	150 °C, mPa·s			0.0 N/A		Meets SA	E J300
D4741 or D5481	2	<i>a</i> :		IIIdA						
HTCBT, 135 °C	Copper,	mg/kg increase,	max				20		20	
(D6594)	Lead, mộ	g/kg increase, m	ax				120		120	
	Copper s	strip rating, ² max					3		3	
Noack (D5800)	Evaporat	tive loss at 250	C, %, max				13		13	
	Foaming	/settling, ^c Seque	ence I, mL, max				10/0		10/0	
Foam (D892)	Foaming	/settling, ^c Seque	ence II, mL, max				20/0		20/0	
	Foaming	/settling, ^c Seque	ence III, mL, max	x			10/0		10/0	
D7109 and HTHS Viscosity after 90	Kinemati	ic viscosity after	90 pass shearin	g, mm²/s at 100 °C, min			xW-30)	0W-40	Other xW-40
pass shearing (see							9.3		12.5	12.8
above methods)		scosity at 150°C	, mPa·s, min				3.4		N/A	N/A
1 (D6896)	viscosity	, 180 h used oli	sample from a 1	-11/1-11A test, tested at	–20 °C, r	nPa·s,	25 00	J	25 00	0
(D7156 Engine test	Yield stre	ess of the 180 h	used oil sample	above. Pa max			≤35		≤35	
				Chemical Limits (non	-critical)					
Test Method			Measured	Parameter	ontioury			Primary P	erformance Crite	eria
D874	Mass f	raction sulfated a	ash. %. max						1.0	
	Mass f	raction phospho	rus, %, max						0.12	
D4951	Mass f	raction sulfur, %	, max						0.4	
				D7216 (Elastomer Con	npatibility	')				
Note—These are the	unadjuste	ed specification l	imits for elastom	er compatibility. Candida	te oils sha	, all, hov	vever, confo	rm to the <i>adju</i>	sted specification	on limits, the
calculation of which is	describe	d in Annex A5.		1					T	
Elastomer		Volume C	hange, %	Hardness Change, P	oints	Tens	ile Strength	Change, %	Elongation at	Break Change, %
Nitrile (NBR)		(+5, -3)		(+7, -5)	((+10, -	-IMC 1006)		(+10, –TMC 10	06)
Silicone (VMQ)		(+1 MC 1006, -3	5)	(+5, -IMC 1006)	((+10, -	45)		(+20, -30)	
Polyacrylate (ACM)	0	(+5, -3)		(+8, -5)	((+18, -	-15)		(+10, -35)	20)
⊢luoroelastomer (FKN	/1)	(+5, -2)		(+1, -5)	((+10, -	TMC 1006)		(+10, -TMC 10	00)
	o doci-	(+ I MC 1006, -3) ronoo oli	(+5, -1 MC 1006)	opionetic	(+10, –	- I MC 1006)	لمتعمل المتعا	(+10, -1MC 10	UD)
of TMC 1006.	ie uesign	auon for the refe	rence on used if	i uns lest method. This d	esignation	n repre	sents the or	iginal blend o	subsequent ap	proved re-biends

TABLE 5 Diesel Engine Oil Category CK-4

^A See Annex A7 for additional information.
 ^B The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.
 ^C Ten minutes for Sequence I, II, and III.

				e Bieser Engine en e	atogory IA 4			
Required Test Method	Engine 1	Test Method		Rated or Measured Parame	eter	Prir	nary Performanc	e Criteria
						One-test	Two-test ^A	Three-test ^A
T-12 (D7422)	П	7422	Top Ring Mass L	oss, mg, max		105	105	105
1-12 (<u>01422</u>)		1422	Cylinder Liner W	ear, µm, max		24.0	24.0	24.0
			R Peak at EOT,	Abs., cm ⁻¹		125	130	133
T-13 (<u>D8048</u>)	D	8048	Kinematic Viscos	ity Increase at 40 °C, % max		75	85	90
			Avg. Oil Consum	ption, 48 h to 192 h, g/h, max		Report	Report	Report
			TGA % Soot at 4	.0 mm²/s increase. at 100 °C. r	nin	3.5	3.4	3.3
T-11 (D7156)	О	7156	TGA % Soot at 1	2.0 mm ² /s increase at 100 °C	min	6.0	5.9	59
(<u>21.100</u>)	-		TGA % Soot at 1	$5.0 \text{ mm}^2/\text{s}$ increase at 100 °C.	min	6.7	6.6	6.5
C13 (D7540)		7540	Morit roting A min		111111	1000	1000	1000
$C13(\frac{D7349}{D7349})$		0047	Average Assetion	$A _{40} = t_{20} = 50 = 0/$		11.0	11.0	11.8
CUAT (<u>D0047</u>)		0047	Average Aeration	i,-4011 to 5011, 76		11.0	11.0	11.0
			Slider tappet mas	ss loss, mg, average, max		100	108	112
ISB (<u>D7484</u>)		<u>17484</u>	Cam lobe wear, p	um, average, max		55	59	61
			Crosshead mass	loss, mg, average		Report	Report	Report
ISM (D7468)	О	7468	Top Ring Mass L	oss, mg, max		100	100	100
			Merit Rating, ^A			1000	1000	1000
			Weighted demeri	ts (WDN), max		286.2	311.7	323.0
			Top groove fill (T	GF), %, max		20	23	25
			Top land heavy c	arbon (TLHC), %, max		3	4	5
					g/kWh, (0 h to	252 0.54	0.54	0.54
1N (<u>D6750</u>)	<u>D</u>	<u>6750</u>			h), max			
			Oli consumption		(g/MJ) (0 h to 2	252 (0.15)	(0.15)	(0.15)
					h), max			
			Piston, ring, and	liner scuffing		none	none	none
			Piston ring stickir	ng	none	none	none	
		FOCC	Average nin wear				0.33	0.36
RFWI (<u>D3900</u>)		0900	Average pin wea	,	(µm) max	(7.6)	(8.4)	(9.1)
				FA-4 Category Bench Te	sts			
Test M	Nethod			Measure	d Parameter			Primary
								Performance
								Criteria
				SAE J300 \	/iscosity Grade			SAE xW-30
<u>D4683</u>						m	in	2.9
or D4741 or D5481			High temperature	e/nigh shear viscosity at 150°C	, mPa·s	ma	ax	3.2
<u>D4741</u> 01 <u>D3401</u>			Connor ma/ka ir	orogoo moy				20
UTOPT 125 °E (D6504	1)		Lood ma/kg inor					120
псы, 135 г (<u>D0394</u>	±)		Ceau, mg/kg mch					120
			Copper strip ratin	ig,= max				
Noack (<u>D5800</u>)			Evaporative loss	at 250 °C, %, max				13
			-oaming/settling,	Sequence I, mL, max				10/0
Foam (<u>D892</u>)			Foaming/settling,	^e Sequence II, mL, max				20/0
			Foaming/settling,	[⊆] Sequence III, mL, max				10/0
<u>D7109</u>			Kinematic viscos	ity after 90 pass shearing, mm	²/s at 100 °C, min			9.3
and HTHS Viscosity (se	ee above i	methods)	HTHS Viscosity a	at 150 °C, mPa·s, min				2.8
after 90 pass snearing								
Sooted Oil MRV TP-1 ((<u>D6896</u>)		Viscosity, 180 h l	used oil sample from a 1-11/1-	11A test, tested at	-20 °C, mPa·s, m	ax	25 000
(D7156 Engine test red	quirea)		Yield stress of the	e 180 h used oil sample above	, Pa max			≤35
				Chemical Limits (non-criti	cal)			
Test N	Nethod			Measure	d Parameter			Primary
								Performance
D074								Criteria
<u>D874</u>			Mass fraction s	ulfated ash, %, max				1.0
D4951			Mass fraction p	hosphorus, %, max				0.12
			Mass fraction s	ulfur, %, max				0.4
				D7216 (Elastomer Compati	bility)			
Note—These are the <i>u</i>	inadjusted	specification	limits for elastom	er compatibility. Candidate oils	shall, however, co	nform to the adjust	sted specification	<i>limits</i> , the
	uescribed	III <u>AIIIIEX A5</u> .	Change 0/	Hardness Oberes D. 11	Terrally Of	noth Channel Of		Dreak Ok 0/
Elastomer	<u> </u>	voiume	unange, %	Hardness Change, Points		ngin Unange, %	Elongation at	Dieak Change, %
	[+	-5, -3)	2)	(+/, -5)	+10, -1MC 10	(סטנ	<u>+10, -1MC 10</u>	00)
Silicone (VMQ)	(+	- I MC 1006, -	-3)	(+5, -1MC 1006)	(+10, -45)		(+20, -30)	
Polyacrylate (ACM)	(+	-5, –3)		(+8, –5)	(+18, –15)		(+10, –35)	
Fluoroelastomer (FKM)) (+	-5, –2)		(+7, –5)	(+10, –TMC 10	006)	(+10, –TMC 10	06)
Vamac G	(+	-TMC 1006, -	-3)	(+5, –TMC 1006)	(+10, –TMC 10	006)	(+10, –TMC 10	06)
Note—TMC 1006 is the	e designati	ion for the ref	erence oil used ir	this test method. This designation	ation represents the	original blend or	subsequent appr	oved re-blends of
TMC 1006.				_				

TABLE 6 Diesel Engine Oil Category FA-4

^A See <u>Annex A7</u> for additional information.
 ^B The rating system in Test Method <u>D130</u> is used to rate the copper coupon in Test Method <u>D6594</u>.
 ^C Ten minutes for Sequence I, II, and III.

{A new listing of the X Appendices X1. Through X8. are included below (X1, X3, and X4 are unchanged)}
{All tables inside Appendix X2 were removed and listed in their New X Appendix Order:}
{X5 (ILSAC GF-6A/GF-6B)}
{X6 (API SERVICE CATEGORY SM)}
{X7 (API SERVICE CATEGORY SN AND API SN WITH RESOURCE CONSERVING AND API SN WITH SN PLUS)}
{X8 (API SERVICE CATEGORY SP)}

APPENDIXES

(Nonmandatory Information)

X1. CLASSIFICATION MAINTENANCE

X1.1 Successful changes in minimum performance standards rely on close coordination among all affected parties. Technical societies, trade associations, original equipment manufacturers, oil and additive marketers, and consumers may perform different roles to define the need, develop the test methods, and establish oil performance limits.

X1.2 A new definition of oil performance can be requested by any individual, company, or association, including ILSAC, API, EMA, ILMA, ACC, any individual marketer, additive supplier, or original equipment manufacturer (OEM), the U. S. Army, or consumer.

X1.3 Appropriate organizations (detailed in API 1509, Annex C or Annex D) consider the request for a new definition of oil performance, and if a need is deemed to exist, test methods are chosen, or developed if none are available or suitable.

X1.4 Oil performance pass/fail criteria are generally selected through technical society consensus procedures, and after appropriate balloting, a new minimum oil performance standard is established.

X1.5 Typically, API then ballots the new standard for inclusion in API 1509, and develops consumer language, the designation, and licensing requirements for the new engine oil category.

X1.6 For a comprehensive description of how new oil performance standards are developed, refer to (API 1509, Annex C or Annex D.

X2. API DESCRIPTIONS

X2.1 SJ (See Table 1 SJ Section)

X2.1.1 API Service Category SJ is to be adopted in 1996 for use in describing engine oil first mandated in 1997. This oil is for use in service typical of gasoline engines in current and earlier passenger car, van, and light truck operation under vehicle manufacturers' recommended maintenance procedures.

X2.1.2 Engine oils developed for this category provide performance exceeding the minimum requirements for API Service Category SH, which Service Category SJ is intended to replace. SJ has new requirements in the areas of volatility, water compatibility, foam inhibition, low temperature properties, high temperature deposit control, and phosphorus limits. All SJ oils must meet specified bench and engine tests.

X2.1.3 Engine oils that meet the API SJ designation have been tested in accordance with ACC Product Approval Code of Practice. These oils may use the API Base Oil Interchange Guidelines and the API Viscosity-Grade Read Across Guidelines, and may be used where API Service Category SH and earlier categories have been recommended.

X2.2 SL—2001 Gasoline Engine Warranty Maintenance Service (See Table 1 SL Section)

X2.2.1 API Service Category SL is for use in describing engine oils available in 2001. These oils are for use in service typical of gasoline engines in current and earlier passenger car, sport utility vehicle, van, and light truck operations under vehicle manufacturers' recommended maintenance procedures.

X2.2.2 Engine oils that meet the API Service Category SL designation (see Annex G of API Publication 1509) may be used where API Service Category SJ and earlier Categories have been recommended.

X2.2.3 Engine oils that meet the API Service Category SL designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F of API Publication 1509).

X2.2.4 Engine oils that meet these requirements may display API Service Category SL in the upper portion of the API Service Symbol.

X2.3 SM—2005 Gasoline Engine Warranty Maintenance Service (See Appendix X6)

X2.3.1 API Service Category SM was adopted for use in describing engine oils available in 2004. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures.

X2.3.2 Engine oils that meet the API Service Category SM designation (see Table X6.1 and Annex G of API Publication 1509) may be used where API Service Category SL and earlier S Categories have been recommended.

X2.3.3 Engine oils that meet the API Service Category SM designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F of API Publication 1509).

X2.3.4 Starting November 30, 2004, oils that meet these requirements may display API Service Category SM in the upper portion of the API Service Symbol. Before the November 30, 2004, introduction date, oil marketers may license API SM oils as API SL.

X2.4 SN—2011 Gasoline Engine Warranty Maintenance Service (See Appendix X7)

X2.4.1 API Service Category SN was adopted for use in describing engine oils available in 2011. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures. Vehicle owners and operators should follow their vehicle manufacturer's recommendations on engine oil viscosity and performance standard.

X2.4.2 Engine oils that meet the API Service Category SN designation (see Table X7.1 and Annex G, of API Publication 1509) may be used where API Service Category SM and earlier S categories have been recommended.

X2.4.3 Engine oils that meet the API Service Category SN designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F of API Publication 1509).

X2.4.4 Engine oils that meet these requirements may display API Service Category SN in the upper portion of the API Service Symbol.

X2.5 Resource Conserving Oil Classification in Conjunction with API Service Category SN (See Appendix X7)

X2.5.1 The Resource Conserving oil classification for gasoline-powered passenger cars, sport utility vehicles, vans, and light-duty trucks is a supplementary classification for engine oils that have resource conserving properties and is displayed—when used—in the lower portion of the API Service Symbol. The performance requirements for this supplementary classification are described technically in SAE J1423 and ASTM D4485 (latest version). Testing for conformance to this classification must be in accordance with the ACC Code. The API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F) may be used.

X2.5.2 API Service SN engine oils designated as Resource Conserving are formulated to help improve fuel economy and protect vehicle emission system components in passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have demonstrated a fuel economy improvement (FEI) in a specific sequence test at the percentages listed in Table X7.2 when compared with a baseline oil (BL). Additionally, these oils have demonstrated in other tests listed in Table X7.2 that they provide greater emission system and turbocharger protection and help protect engines when operating on ethanol-containing fuels up to E85.

X2.5.3 Resource Conserving in conjunction with API SN focuses on fuel economy, emission system and turbocharger protection, and compatibility with ethanol-containing fuel up to E85.

X2.5.4 Oils that have passed the tests at the limits shown in Table X7.2 and are properly licensed by API may display "Resource Conserving" in the lower portion of the API Service Symbol in conjunction with API Service SN in the upper portion. The fuel economy and other resource conserving benefits obtained by individual vehicle operators using engine oils labeled Resource Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits.

X2.6 SN PLUS Classification in Conjunction with API Service Category SN and API SN with Resource Conserving (See Appendix X7)

X2.6.1 API Service Category SN engine oils that also carry the classification SN PLUS are formulated to provide API SN performance and additional protection against low-speed pre-ignition for turbocharged direct injection gasoline-powered vehicles.

X2.6.2 Oils that meet the requirements for API SN with SN PLUS or API SN with SN PLUS and Resource Conserving at the limits shown in Table X7.2 or API Publication 1509 Annex G, and are properly licensed may display "SN PLUS" or "Resource Conserving SN PLUS" in the lower portion of the API Service Symbol in conjunction with API SN in the upper portion.

X2.6.3 Oils that satisfy SN PLUS can also effectively lubricate engines calling for API SN, API SN with Resource Conserving, API SN with SN PLUS and API SN with SN PLUS and Resource Conserving are also backward compatible to API Service Categories before API SN.

X2.7 SP—2020 Gasoline Engine Warranty Maintenance Service (see Appendix X8)

X2.7.1 API Service Category SP was adopted for use in describing engine oils available in 2020. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures. Vehicle owners and operators should follow their vehicle manufacturer's recommendations on engine oil viscosity and performance standard.

X2.7.2 Engine oils that meet the API Service Category SP designation may be used where API Service Category SN and earlier S categories have been recommended.

X2.7.3 Engine oils that meet the API Service Category SP designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F, API Publication 1509).

X2.7.4 Engine oils that meet these requirements may display API Service Category SP in the upper portion of the API Service Symbol beginning May 1, 2020.

X2.8 Resource Conserving in Conjunction with API Service Category SP (see Appendix X8)

X2.8.1 API Service SP engine oils designated as Resource Conserving are formulated to help improve fuel economy and protect vehicle emission system components in passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines.

These oils have demonstrated a fuel economy improvement (FEI) in a specific sequence test at the percentages listed in Table X8.2 when compared with a baseline oil (BL). Additionally, these oils have demonstrated in other tests listed in Table X8.2 that they provide greater emission system and turbocharger protection and help protect engines when operating on ethanol-containing fuels up to E85.

X2.8.2 Many previous S Categories made reference to "Energy Conserving," but this reflected an emphasis on fuel-economy performance alone. Resource Conserving in conjunction with API SP focuses on fuel economy, emission system and turbocharger protection, and compatibility with ethanol-containing fuel up to E85.

X2.8.3 Starting May 1, 2020, oils that have passed the tests at the limits shown in Table X8.2 and are properly licensed by API may display "Resource Conserving" in the lower portion of the API Service Symbol in conjunction with API Service SP in the upper portion. The fuel economy and other resource conserving benefits obtained by individual vehicle operators using engine oils labeled Resource Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits. Before the May 1, 2020, introduction date, oil marketers may license oils meeting Resource Conserving in conjunction with API Service SP as Resource Conserving in conjunction with API Service SN.

X2.9 CH-4—1998 Diesel Engine Service

X2.9.1 API Service Category CH-4 describes oils for use in those high-speed, four stroke-cycle diesel engines designed to meet 1998 exhaust emission standards as well as for previous model years. API CH-4 oils are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5 % by weight.

X2.9.2 These oils are especially effective to sustain engine durability even under adverse applications that may stress wear control, high-temperature stability, and soot handling properties. In addition, optimum protection is provided against nonferrous corrosion, oxidative and insolubles thickening, foaming, and viscosity loss due to shear. These oils also have the performance capability to afford a more flexible approach to oil drain intervals in accordance with the recommendations of the individual engine builders for their specific engines.

X2.10 CI-4—For 2004 Severe Duty Diesel Engine Service

X2.10.1 API Service Category CI-4 describes oils for use in high-speed, four-stroke cycle diesel engines designed to meet 2004 exhaust emission standards implemented in 2002. These oils are intended for use in all applications with diesel fuels ranging in sulfur content up to 0.5 % weight.

X2.10.2 These oils are specifically formulated to sustain engine durability where Exhaust Gas Recirculation (EGR) is used and the impact of these oils on other supplemental exhaust emission devices has not been determined. Optimum protection is provided against corrosive and soot-related wear tendencies, piston deposits, degradation of low- and high-temperature viscometric properties due to soot accumulation, oxidative thickening, loss of oil consumption control, foaming, degradation of seal materials, and viscosity loss due to shear.

X2.10.3 Engine oils that meet the API Service Category CI-4 designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing.

X2.10.4 CI-4 oils are superior in performance to those meeting API CH-4, and may be used in engines calling for that API Service Category.

X2.10.5 The first license date for CI-4 will be September 5, 2002.

X2.10.6 Effective January 15, 2002, marketers may license products meeting API CI-4 requirements as CH-4.

X2.11 CJ-4—2007 Diesel Engine Service

X2.11.1 API Service Category CJ-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2007 model year on-highway exhaust emission standards as well as for previous model years.

X2.11.2 These oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact aftertreatment system durability and/or oil drain interval.

X2.11.3 These oils are especially effective at sustaining emission control system durability where particulate filters and other advanced aftertreatment systems are used. Optimum protection is provided for control of catalyst poisoning, particulate filter blocking, engine wear, piston deposits, low- and high-temperature stability, soot handling properties, oxidative thickening, foaming, and viscosity loss due to shear.

X2.11.4 Engine oils that meet the API Service Category CJ-4 designation have been tested in accordance with the ACC Code and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing.

X2.11.5 API CJ-4 oils exceed the performance criteria of API CI-4 with CI-4 PLUS, CI-4 and CH-4, and can effectively lubricate engines calling for those API Service Categories. When using CJ-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval.

X2.11.6 The first license date for API CJ-4 will be October 15, 2006.

X2.11.7 Effective May 1, 2006, marketers may license products meeting API CJ-4 requirements as API CI-4 with CI-4 PLUS, CI-4, and CH-4.

X2.12 CK-4—For 2017 Heavy-Duty Diesel Engine Service

X2.12.1 API Service Category CK-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05 % by weight). However, the use of these oils with greater than 15 ppm (0.0015 % by weight) sulfur fuel may impact exhaust after-treatment system durability and/or

oil drain interval.

X2.12.2 These oils are especially effective at sustaining emission control system durability where particulate filters and other advanced aftertreatment systems are used. API CK-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear, and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties, and soot-related viscosity increase.

X2.12.3 Engine oils that meet the API Service Category CK-4 designation have been tested in accordance with the ACC Code of Practice and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Read Across shown in API Publication 1509.

X2.12.4 API CK-4 oils exceed the performance criteria of API CJ-4, CI-4 with CI-4 PLUS, CI-4, and CH-4 and can effectively lubricate engines calling for those API Service Categories. When using CK-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval recommendations.

X2.12.5 Marketers may license products meeting API CK-4 requirements as API CJ-4, CI-4 with CI-4 PLUS, CI-4, and CH-4.

X2.13 FA-4—For 2017 Heavy-Duty Diesel Engine Service

X2.13.1 API Service Category FA-4 describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015 % by weight). Refer to individual engine manufacturer recommendations regarding compatibility with API FA4 oils.

X2.13.2 These oils are blended to a high temperature high shear (HTHS) viscosity range of 2.9 cP to 3.2 cP to assist in reducing GHG emissions. These oils are especially effective at sustaining emission control system durability where particulate filters and other advanced after treatment systems are used. API FA-4 oils are designed to provide enhanced protection against oil oxidation, viscosity loss due to shear, and oil aeration as well as protection against catalyst poisoning, particulate filter blocking, engine wear, piston deposits, degradation of low- and high-temperature properties, and soot-related viscosity increase.

X2.13.3 Engine oils that meet the API Service Category FA-4 designation have been tested in accordance with the ACC Code of Practice and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Read Across shown in API Publication 1509.

X2.13.4 API FA-4 oils are not interchangeable or backward compatible with API CK-4, CJ-4, CJ-4, CI-4 with CI-4 PLUS, CI-4, and CH-4 oils. Refer to engine manufacturer recommendations to determine if API FA-4 oils are suitable for use. API FA-4 oils are not recommended for use with fuels having greater than 15 ppm sulfur. For fuels with sulfur contents greater the 15 ppm, refer to engine manufacturer recommendations.

X3. AMERICAN CHEMISTRY COUNCIL PETROLEUM ADDITIVES PANEL PRODUCT APPROVAL CODE OF PRACTICE

X3.1 Through the American Chemistry Council (ACC) Petroleum Additives Panel, the Product Approval Protocol Task Group developed the Product Approval Code of Practice for engine oil testing that was implemented in March 1992. Compliance with the Code of Practice is voluntary. The American Petroleum Institute (API) requires that all engine tests conducted in support of API certification and licensing be conducted under the ACC Product Approval Code of Practice. More information is available from the ACC website:

http://www.americanchemistry.com/paptg

X4. MACK T-10 MERIT CALCULATIONS USING MACK T-12 RESULTS

X4.1 Various oil specifications may use T-12 test results to obtain T-10 Mack Merits, using the calculation methodology shown in X4.2 - X4.3.

X4.2 Merit System Components

X4.2.1 Anchors-Anchor performance level based on one test.

X4.2.2 Maximums—Limit of acceptable performance.

X4.2.3 Minimums-Limit of best performance.

X4.2.4 Weights-Relative contribution to total merit.

X4.2.5 *Multipliers*—Using Table X4.1, determine the multiplier for each parameter as follows:

Criterion	0 h – 300 h Delta Pb	250 h – 300 h Delta Pb	Cylinder Liner Wear	Top Ring Weight Loss	Oil Consumption
Weight	200	200	250	200	150
Maximum	42	18	26.0	117	95.0
Anchor	35	13	23.0	82	82.0
Minimum	10	0	12.0	47	50.0

TABLE X4.1 Multipliers

X4.2.5.1 If a result is at the anchor, multiplier is one (for example, Liner Wear = 23 yields multiplier = 1).

X4.2.5.2 If a result is at or below the minimum, multiplier is two (for example, Liner Wear = 10 yields multiplier = 2).

X4.2.5.3 If a result is at the maximum, multiplier is zero (for example, Liner Wear = 26.0 yields multiplier = 0).

X4.2.5.4 If a result is between minimum and anchor, linearly interpolate multiplier between 2 and 1 (for example, Liner Wear = 14 yields multiplier = 1.82).

X4.2.5.5 If a result is between anchor and maximum, linearly interpolate multiplier between 1 and 0 (for example, Liner Wear = 25 yields multiplier = 0.33).

X4.2.5.6 If a result is above the maximum, linearly extrapolate multiplier on the same line as between 1 and 0 (for example, Liner Wear = 28.0 yields multiplier = -0.67).

X4.3 *Calculated Merit Result*—Sum the products of weights and multipliers across the five results. This is the calculated merit result. In equation form:

$$Calculated Merit = \sum_{i=1}^{5} Weight_{i}$$

$$x \begin{cases} \delta(result_{i} > anchor_{i}) \times (max_{i} - result_{i}) \\ +\delta(min_{i} < result_{i} \le anchor_{i}) \times [1 + (anchor_{i} - \\ +\delta(result_{i} \le min_{i}) \times] \end{cases}$$

where:

 $\delta(x) = 1$ if x is true; 0 if x is false.

X5. ILSAC GF-6A/GF-6B STANDARD FOR PASSENGER CAR ENGINE OILS (EFFECTIVE MAY 1, 2020) (see Table X5.1 and Table X5.2)

X5.1 The Japan Automobile Manufacturers Association, Inc. and representatives from Fiat Chrysler Automobiles, Ford Motor Company, and General Motors LLC, through an organization called the International Lubricants Standardization Advisory Committee (ILSAC), jointly developed and approved the ILSAC GF-6A and GF-6B minimum performance standards for engine oils for spark-ignited internal combustion engines (see Table X5.1 and Table X5.2).

X5.2 This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for engine oils for spark-ignited internal combustion engines. It is expected that many engine manufacturers will recommend ILSAC GF-6A and/or GF-6B oils. However, performance parameters other than those covered by the tests included or more stringent limits on those tests included in these standards may be required by individual OEMs.

X5.3 In addition to meeting the requirements of the standards, it is the oil marketer's responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information when marketing products meeting the ILSAC GF-6A and GF-6B standards. It is also the marketer's responsibility to conduct its business in a manner that represents minimum risk to consumers and the environment.

X5.4 The ultimate assessment of an engine oil's performance must include a variety of vehicle fleet tests that simulate the full range of customer driving conditions. The engine sequence tests listed in this document have been specified instead of fleet testing to minimize testing time and costs. This simplification of test requirements is only possible because the specified engine sequence tests have been judged to be predictive of a variety of vehicle tests.

X5.5 The relationships between engine sequence tests and vehicle fleet tests are judged valid based only on the range of base oils and additive technologies investigated—generally those that have proven to have satisfactory performance in service and that are in widespread use at this time. The introduction of base oils or additive technologies that constitute a significant departure from existing practice requires sufficient supporting vehicle fleet testing data to ensure there is no adverse effect to vehicle components or to emission control systems. This vehicle fleet testing should be conducted in addition to the other performance requirements listed in these standards.

X5.6 It is the responsibility of any individual or organization introducing a new technology to perform this vehicle fleet testing, and the responsibility of the oil marketer to ensure the testing of new technology was satisfactorily completed. No marketer can claim to be acting in a reasonable and prudent manner if they knowingly use a new technology based only on the results of engine sequence testing without verifying the suitability of the new technology in vehicle fleet testing that simulates the full range of customer operation.

X5.7 The ILSAC GF-6A and GF-6B Minimum Performance Standards include tests for which Viscosity Grade Read Across and Base Oil Interchange Guidelines have been developed by the appropriate groups. It should be pointed out, however, that when oil marketers use the guidelines, they do so based on their own judgment and at their own risk. The use of any guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-6A or GF-6B with API.

TABLE X5.1 ILSAC GF-6A Passenger Car Engine Oil Standard

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Requirements Culture SAE, J300 Culture at all requirements of SAE, J300. Viscosity grades are initiad to SAE 004-20, 0V-30, VA30, VA30, SV-30, SV-30, multi-grades are initiad to SAE 004-20, CM-30, VA30, VA30, SV-30, SW-30, multi-grades are initiad to SAE 004-20, CM 2-50, SW-30, S		
Frank D Wiscoble Requirements SAE J300 Oils shall meet all requirements of SAE J300. Vaccosity grades are timited to SAE UA20. UV-30, UV-30, UV-30, VAC-30, V	Requirement	Criterion
SAE, 1900 Oile shall most all regut montes of SAE, 2000. Provide grades are lembed to SAE, DWA20, DWA20, SWA20, SWA2	Fresh Oil Viscosity Requirements	
Genation index ASTM D0533 I 2 (mma) To be evaluated from -5 (10 immportun at which 40000 cP is attained or -40 °C, or 2 * 10 imm portune at which 40000 cP is attained or -40 °C, or 2 * 10 imm portune at which 40000 cP is attained or -40 °C, or 2 * 10 imm portune at which 40000 cP is attained or -40 °C, or 2 * 10 imm portune at which 40000 cP is attained or -40 °C, or 2 * 10 imm portune at which 40000 cP is attained or -40 °C, or 2 * 10 °C, which are 1000 imm portune at which 40000 cP is -40 °C, or 2 * 1000 imm portune at which 42 (min) Kinematic vaccult imps ASTM Sequence VI (ASTM D0256) Average engine atadge, ments 7 E (min) Average engine atadge, wasa Rate and report Oil scene atadge, wasa Rate and report Oil scene atadge, wasa Rate and report Or atage angle atage atage 7 (max) Average intak fifter volume oses (§ position ang), mm ² 27 (max) Average intak fifter volume oses (§ position ang), mm ² 27 (max) Average intak fift	SAE J300	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 multi-grade oils
12 (mx) To be exhaled forn -5 °C to ineprature at which 40 000 Pe is attained or -40 °C, or 2 °C below appropriate MPV TP-1 temperature (defined by SAE a)300, whichwer cours first Engine Tost Requirements ASTIM Sequence IIII4 (ASTM D811) Kinematic viscosity increase (2 40 °C, % 100 (max) Average wighted pation depoints, ments 4.21 (m) Hot stuck ring None Vear, atodity, and varnish 7.4 (m) Average orgine variants, ments 7.4 (m) Average argine variants, ments 7.6 (m) Average argine variants, ments 7.6 (m) Average argine variants, ments 8.6 (m) Average argine variants, ments 7.6 (m) Oll screen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area Rela and roport Ito is creen aldvide, 's area <	Gelation index	ASTM D5133
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Waar and it hickeningASTM Sequence IIII (ASTM DB11)Kinematic viscosity increase @ 40°C, %100 (max)Average weighted piston deposits, metts42 (min)Not suck, fingsNoneWaar, aludga, motilsASTM Sequence WH (ASTM DB256)Average ergine sukap, metts7.6 (min)Average ergine sukap, metts7.6 (min)Average ergine sukap, metts8.6 (ma)Average ergine sukap, metts8.6 (ma)Average ergine sukap, metts7.6 (min)Oil screen subqe, metts7.6 (min)Oil screen devis, % areaRate and reportOil screen devis, % areaRate and reportAverage instable, filter outure loss (& position avg), mm ³ 2.7 (ma)Average instable, filter outure loss (& position avg), mm ³ 2.7 (ma)End of test inor, pp400 (max)Bauring corrosionASTM Sequence VII (ASTM DB270)Bauring corrosionASTM Sequence VII (ASTM DB11)SAE XVe2 Overosity grade1.8 (ma)FEI SUM3.8 (min)FEI SUM3.8 (min)SAE XVe2 Overosity grade1.8 (min) faster 122 hours agingSAE XVe2 Overosity grade1.8 (min) f	Engine Test Requirements	
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Oil ring clogging, % areaRate and reportValvetrain wearASTM Sequence IVB (ASTM D8350)Average intake lifter volume loss (8 position avg), mm³2.7 (max)End of test lion, ppm400 (max)Bearing corrosionASTM Sequence VIII (ASTM D6709)Bearing weight loss, mg26 (max)Fuel EfficiencyASTM Sequence VIE (ASTM D814)SAE XW-20 viscosity grade	Cold stuck rings	Rate and report
Valvetrain wear ASTM Sequence IVB (ASTM D8350) Average intake lifter volume loss (8 position avg), mm ³ 2.7 (max) End of test iron, ppm 400 (max) Bearing corrosion ASTM Sequence VIII (ASTM D6709) Bearing weight loss, mg 26 (max) Fuel Efficiency ASTM Sequence VIE (ASTM D8114) SAE XW-20 viscosity grade	Oil ring clogging, % area	Rate and report
Average intake lifter volume loss (8 position avg), mm³ 2.7 (max) End of test iron, ppm 400 (max) Bearing corrosion ASTM Sequence VIII (ASTM D6709) Bearing weight loss, mg 26 (max) Fuel Efficiency ASTM Sequence VIE (ASTM D8114) SAE XW-20 viscosity grade . FEI SUM 3.8 % min FEI 2 1.8 % min after 125 hours aging SAE XW-30 viscosity grade . FEI SUM 3.1 % min FEI 2 1.5 % min after 125 hours aging SAE 10W-30 viscosity grade . FEI 2 1.3 % min after 125 hours aging SAE 10W-30 viscosity grade . FEI 2 1.3 % min after 125 hours aging Vaerage number of events for four iterations 5 (max) Average number of events for four iterations 5 (max) Chain wear ASTM Sequence X (ASTM D8291) Average number of events for four iterations 6 (max) Chain wear ASTM Sequence X (ASTM D8279) Percent increase 0.085 (max) Bonch Test Requirements . Catalyst compatibility ASTM D4951 or D5185 Phosphorus content, %	Valvetrain wear	ASTM Sequence IVB (ASTM D8350)
End of test iron, ppm400 (max)Bearing vergish Loss, mgASTM Sequence VIII (ASTM D6709)Bearing weight Loss, mg26 (max)Fuel EfficiencyASTM Sequence VIE (ASTM D8114)SAE XW-20 viscosity grade	Average intake lifter volume loss (8 position avg), mm ³	2.7 (max)
Bearing corrosion ASTM Sequence VII (ASTM D6709) Bearing weight loss, mg 26 (max) Fuel Efficiency ASTM Sequence VIE (ASTM D8114) SAE XW-20 viscosity grade 1 FEI SUM 3.8 % min FEI SUM 3.1 % min after 125 hours aging SAE XW-30 viscosity grade 1.5 % min after 125 hours aging FEI SUM 3.1 % min FEI SUM 3.1 % min after 125 hours aging SAE 10W-30 viscosity grade 2.8 % min FEI SUM 2.8 % min FEI 2 1.3 % min after 125 hours aging Low-speed pre-ignition prevention ASTM Sequence IX (ASTM D8291) Average number of events for four iterations 5 (max) Number of events per iteration 8 (max) Chain wear ASTM Sequence X (ASTM D8279) Percent increase 0.085 (max) Bench Test Requirements 2 Catalyst compatibility ASTM D4951 or D5185 Phosphorus content, % (mass) 0.08 (max) Phosphorus content, % (mass) 0.5 (max) <td< td=""><td>End of test iron, ppm</td><td>400 (max)</td></td<>	End of test iron, ppm	400 (max)
Bearing weight loss, mg 26 (max) Fuel Efficiency ASTM Sequence VIE (ASTM D8114) SAE XW-20 viscosity grade 3.8 % min FEI SUM 3.8 % min after 125 hours aging SAE XW-30 viscosity grade 1.8 % min after 125 hours aging FEI SUM 3.1 % min FEI 2 1.5 % min after 125 hours aging SAE 10W-30 viscosity grade 1.5 % min after 125 hours aging FEI 2 1.5 % min after 125 hours aging SAE 10W-30 viscosity grade 2.8 % min FEI 2 1.3 % min after 125 hours aging SAE 10W-30 viscosity grade 2.8 % min FEI 2 1.3 % min after 125 hours aging Low-speed pre-ignition prevention ASTM Sequence IX (ASTM D8291) Average number of events for four iterations 5 (max) Number of events per iteration 8 (max) Chain wear ASTM Sequence X (ASTM D8279) Percent increase 0.08 (max) Bench Test Requirements 2 Catalyst compatibility ASTM D4951 or D5185 Phosphorus content, % (mass) 0.08 (max) Phosphorus content, % (mass) 0.5 (max) SAE UW and SW multigrades, % (mass) <	Bearing corrosion	ASTM Sequence VIII (ASTM D6709)
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Phosphorus content, % (mass) 0.06 (min)	Wear	ASTM D4951 or D5185
	Phosphorus content, % (mass)	0.06 (min)

Requirement	Criterion
Volatility	ASTM D5800(B&D)
Evaporation loss, %	15.0 (max), 1 hour at 250 °C
High temperature deposits	TEOST 33C (ASTM D6335)
Total deposit weight, mg	30 (max)
	Note: No TEOST 33C limit for SAE 0W-20.
Filterability	ASTM D6794
EOWTT, %	
with 0.6% H ₂ O	50 (max) flow reduction
with 1.0% H ₂ O	50 (max) flow reduction
with 2.0% H ₂ O	50 (max) flow reduction
with 3.0% H ₂ O	50 (max) flow reduction
	Note: Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.
EOFT, %	ASTM D6795
	50 (max) flow reduction
Fresh oil foaming characteristics	ASTM D892 (Option A and excluding Section 11 Alternative Procedure)
Tendency, mL	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Stability, mL, after 1-minute settling	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
Fresh oil high temperature foaming characteristics	ASTM D6082 (Option A)
Tendency, mL	100 (max)
Tendency, mL Stability, mL, after 1-minute settling	100 (max) 0 (max)
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity	100 (max) 0 (max) ROBO (ASTM D7528)
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade)
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade) c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade OR	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade) c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity grade or the next higher viscosity grade, depending on the original viscosity grade, as outlined in a) or b) above.
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade OR Aged oil low temperature viscosity	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade) c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above. ASTM Sequence IIIHA (ASTM D8111)
Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade OR Aged oil low temperature viscosity Measure aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade) c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above. ASTM Sequence IIIHA (ASTM D8111) d) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade.
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Tendency, mL Stability, mL, after 1-minute settling Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade OR Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade Shear stability 10-hour stripped KV @ 100 °C XW-20	100 (max) 0 (max) ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade) c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade, as outlined in a) or b) above. ASTM Sequence IIIHA (ASTM D8111) d) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. e) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). f) EOT IIIHA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade, or the next higher viscosity grade, dependin
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	Requirement		Crite	erion		
			Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center (TMC) reference oils, shall remain miscible.			
Engine rusting			Ball Rust Test (ASTM D6557)			
Average gray value			100 (min)			
Emulsion retention			ASTM D7563			
0 °C, 24 hours			No water separation			
25 °C, 24 hours			No water separation			
Elastomer compatibility			ASTM D7216 Annex A2			
			Candidate oil testing for elastomer con five Standard Reference Elastomers (\$ SAE J2643. Candidate oil testing shall D7216 Annex A2. The post-candidate- conform to the specification limits deta	npatibility shall be performed using the SREs) referenced herein and defined in be performed according to ASTM oil-immersion elastomers shall iled below:		
Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits		
	ASTM D471	Volume	% Δ	-5, 9		
Polyacrylate Rubber (ACM-1)	ASTM D2240	Hardness	pts.	-10, 10		
	ASTM D412	Tensile Strength	% Δ	-40, 40		
	ASTM D471	Volume	% Δ	-5, 10		
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D2240	Hardness	pts.	-10, 5		
(ASTM D412	Tensile Strength	% Δ	-20, 15		
	ASTM D471	Volume	% Δ	-5, 40		
Silicone Rubber (VMQ-1)	ASTM D2240	Hardness	pts.	-30, 10		
	ASTM D412	Tensile Strength	% Δ	-50, 5		
	ASTM D471	Volume	% Δ	-2, 3		
Fluorocarbon Rubber (FKM-1)	ASTM D2240	Hardness	pts.	-6, 6		
	ASTM D412	Tensile Strength	% Δ	-65, 10		
	ASTM D471	Volume	% Δ	-5, 30		
Ethylene Acrylic Rubber (AEM-1)	ASTM D2240	Hardness	pts.	-20, 10		
(ASTM D412	Tensile Strength	% Δ	-30, 30		

Requirement	Criterion
Fresh Oil Viscosity Requirements	
	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W-16 multi-grade oils
Gelation index	ASTM D5133
	12 (max)
	To be evaluated from $-5\overset{\circ}{C}$ to temperature at which 40 000 cP is attained or $-40\overset{\circ}{C}$, or 2 °C below appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first
Engine Test Requirements	
Wear and oil thickening	ASTM Sequence IIIH (ASTM D8111)
Kinematic viscosity increase @ 40°C, %	100 (max)
Average weighted piston deposits, merits	4.2 (min)
Hot stuck rings	None
Wear, sludge, and varnish	ASTM Sequence VH (ASTM D8256)
Average engine sludge, merits	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)
Oil screen sludge, % area	Rate and report
Oil screen debris, % area	Rate and report
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil ring clogging, % area	Rate and report
Valve train wear	ASTM Sequence IVB (ASTM D8350)
Average intake lifter volume loss (8 position avg.), mm ³	2.7 (max)
End of test iron, ppm	400 (max)
Fuel efficiency	ASTM Sequence VIF (ASTM D8226)
SAE 0W-16 viscosity grade	
FEI SUM	4.1 % min
FEI 2	1.9 % min after 125 hours aging
Low-speed pre-ignition prevention	ASTM Sequence IX (ASTM D8291)
Average number of events for four iterations	5 (max)
Number of events per iteration	8 (max)
Chain wear	ASTM Sequence X (ASTM D8279)
Percent increase	0.085 (max
Bench Test Requirements	
Catalyst compatibility	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.08 (max)
Phosphorus volatility (Sequence IIIHB, phosphorus retention)	ASTM D7320
	81 % (min)
Sulfur content	ASTM D4951, D5185, or D2622
SAE 0W and 5W multi-grades, % (mass)	0.5 (max)
Wear	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.06 (min)
Volatility	ASTM D5800 (B&D)
Evaporation loss, %	15.0 (max), 1 hour at 250 °C
Filterability	ASTM D6794
EOWTT, %	
with 0.6% H ₂ O	50 (max) flow reduction
with 1.0% H ₂ O	50 (max) flow reduction
with 2.0% H ₂ O	50 (max) flow reduction
with 3.0% H ₂ O	50 (max) flow reduction
	Note: Test formulation with highest additive (DI/VI) concentration. Read across
	results to all other base oil/viscosity grade formulations using same or lower

Requirement			Criterion			
		concentration of identica combination must be test	concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.			
EOFT, %		ASTM D6795	ASTM D6795			
		50 (max) flow reduction				
Fresh oil foaming characteristics		ASTM D892 (Option A a	nd excluding paragraph 11)			
Tendency, mL						
Sequence I		10 (max)				
Sequence II		50 (max)				
Sequence III		10 (max)				
Stability, mL, after 1-minute settling						
Sequence I		0 (max)				
Sequence II		0 (max)				
Sequence III		0 (max)				
Fresh oil high temperature foaming characteristics		ASTM D6082 (Option A))			
Tendency, mL		100 (max)				
Stability, mL, after 1-minute settling		0 (max)				
Aged oil low temperature viscosity		ROBO (ASTM D7528)				
Measure aged oil low temperature viscosity on final form read across described in Annex F)—this includes base oil ar licensed—for each viscosity grade by either ROBO or I	a) If CCS viscosity meas specified for the original MRV temperature specif	sured is less than or equal to viscosity grade, run ASTM D fied in SAE J300 for the origir	the maximum CCS viscosity 4684 (MRV TP-1) at the al viscosity grade.			
Measure CCS viscosity of EOT ROBO or IIIHA sample corresponding to original viscosity grade	b) If CCS viscosity meas the original viscosity gra temperature (i.e., at MR' viscosity grade).	b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade).				
	c) EOT ROBO sample n viscosity must be below viscosity grade or the ne grade, as outlined in a) o	c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.				
	0	R				
Aged oil low temperature viscosity		ASTM Sequence IIIHA (ASTM <mark>D8111</mark>)			
Measure aged oil low temperature viscosity on final for read across described in Annex F)—this includes base oil ar licensed—for each viscosity grade by either ROBO or I	d) If CCS viscosity meas specified for the original MRV temperature specif	sured is less than or equal to viscosity grade, run ASTM D fied in SAE J300 for the origin	the maximum CCS viscosity 4684 (MRV TP-1) at the ral viscosity grade.			
Measure CCS viscosity of EOT ROBO or IIIHA sample corresponding to original viscosity grade	at CCS temperature	e) If CCS viscosity meas the original viscosity gra temperature (i.e., at MR viscosity grade).	sured is higher than the maxir de in J300, run ASTM <mark>D4684</mark> V temperature specified in SA	num viscosity specified for (MRV TP-1) at 5 °C higher \E J300 for the next higher		
	f) EOT IIIHA sample mu viscosity must be below viscosity grade or the ne grade, as outlined in a) or	f) EOT IIIHA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.				
Shear stability		Diesel Injector (ASTM D6278)				
KV @ 100 °C after 30 passes, cSt		5.8 (min)	5.8 (min)			
Homogeneity and miscibility		ASTM D6922 Shall remain homogene	ASTM D6922 Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center			
Engine rusting		Ball Ruet Teet (ASTM D	(INIC) reference oils, shall remain miscible.			
Average grav value		100 (min)				
	ASTM D7563	ASTM D7563				
0°C, 24 hours	No water separation	No water separation				
25 C, 24 nours		No water separation				
	Candidate oil testing for Standard Reference Ela J2643. Candidate oil tes A2. The post-candidate-	ASTM D7216 Annex A2 Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Anne: A2. The post-candidate-oil-immersion elastomers shall conform to the				
	Test Dress 1	specification limits detail		1 1		
Polyacrylate Rubber (ACM-1)	ASTM D471 ASTM D2240	Hardness	70 Δ pts	-0, 9		
			- · · · ·	,		

Requirement			Criterion			
	ASTM D412	Tensile Strength	% Δ	-40, 40		
	ASTM D471	Volume	%Δ	-5, 10		
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D2240	Hardness	pts.	-10, 5		
	ASTM D412	Tensile Strength	% Δ	-20, 15		
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40		
	ASTM D2240	Hardness	pts.	-30, 10		
	ASTM D412	Tensile Strength	%Δ	-50, 5		
	ASTM D471	Volume	% Δ	-2, 3		
Fluorocarbon Rubber (FKM-1)	ASTM D2240	Hardness	pts.	-6, 6		
	ASTM D412	Tensile Strength	% Δ	-65, 10		
	ASTM D471	Volume	%Δ	-5, 30		
Ethylene Acrylic Rubber (AEM-1)	ASTM D2240	Hardness	pts.	-20, 10		
	ASTM D412	Tensile Strength	% Δ	-30, 30		

X6. THE API SERVICE CATEGORY SM

X6.1 See Table X6.1

 TABLE X6.1 Requirements for API Service Category SM

 NOTE 1—All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.

Viscosity Grade Performance Requirements				
	SAE 0W-20, SAE 5W-20,	All Others ^B		
Engine Test Requirements ⁴	SAE 0W-30, SAE 5W-30,			
	SAE 10W-30			
ASTM D7320 (Sequence IIIG)				
Kinematic viscosity increase @ 40 °C, %	150 (max)	150 (max)		
Average weighted piston deposits, merits	3.5 (min)	3.5 (min)		
Hot stuck rings	None	None		
Average cam plus lifter wear, um	60 (max)	60 (max)		
OR				
ASTM D8111 (Sequence IIIH)				
Kinematic viscosity increase @ 40 °C %	150 (max)	150 (max)		
Average weighted piston deposits merits	3.2 (min)	3.2 (min)		
Hot stuck rings	None	None		
ASTM D4684 (Sequence IIIGA), ASTM D8111 (Sequence IIIHA), or ASTM D7528 (ROBO)				
Evaluate EOT oil from ASTM Sequence IIIGA, Sequence IIIHA, or ROBO test with ASTM D4684 (MRV TP-1)	ASTM D4684 viscosity of EOT sample must meet requirements of original grade or next higher grade	NR		
ASTM D6891 (Sequence IVA)				
Average cam wear (7 position avg.) µm	90 (max)	90 (max)		
ASTM D6593 (Sequence VG) ^C	7.8 (min)	7.8 (min)		
Average engine sludge, merits	8.0 (min)	8.0 (min)		
Average rocker cover sludge, merits	8.9 (min)	8.9 (min)		
Average engine varnish, merits	7.5 (min)	7.5 (min)		
Average piston skirt varnish, merits	20 (max)	20 (max)		
Oil screen sludge. % area	Rate & report	Rate & report		
Oil screen debris. % area	None	None		
Hot-stuck compression rings	Rate & report	Rate & report		
Cold stuck rings	Rate & report	Rate & report		
Oil ring clogging. % area	Rate & report ^D	Rate & report ^D		
Follower pin wear, cvl #8, avg, µm	Rate & report ^D	Rate & report ^D		
Ring gap increase cyl #1 and #8 avg um	Rate & report ^D	Rate & report ^D		
		hate a report		
Average engine sludge merits	7.4	74		
Average rocker cover sludge, merits	7.4	7.4		
Average engine varnish merits	86	86		
Average histon skirt varnish merits	7.6	7.6		
Oil scroop clogging % area	Pate & report	Pate & report		
ASTM D6709 (Sequence)/III)	None	INDITE		
Begring weight loss mg	26 (max)	26 (max)		
	20 (max)	20 (III8X)		
	Vienesity Orada Data	monoo Roquiromonto		
Bench Test and Measured Parameter ^A				
	SAE UW-30, SAE 5W-30,			
	SAE 1000-30	400		
ASTM D000/ (Ball Rust Lest), avg gray value, min	100	100		
ASTM D5800, evaporation loss, 1 h at 250 °C, % max ^E	15	15		
ASTM D6417, simulated distillation at 371 °C, % max	10	10		

ASTM D6795, EOFT, percent flow reduction, max	50	50
ASTM D6794, EOWTT, percent flow reduction, max		
with 0.6 % H ₂ 0	50	50
with 1.0 % H ₂ 0	50	50
with 2.0 % H ₂ 0	50	50
with 3.0 % H ₂ 0	50	50
ASTM D4951, phosphorus percent mass, max ^F	0.08 ⁶	NR
ASTM D4951, phosphorus percent mass, min ^F	0.06 ⁶	0.06 ^G
ASTM D4951 or D2622, sulfur percent mass, max ^F		
SAE 0W-20, 0W-30, 5W-20, and 5W-30	0.5 ⁶	NR
SAE 10W-30	0.7 ^G	NR
ASTM D892 (Option A), foaming tendency		
Sequence I, mL, max, tendency/stability ^H	10/0	10/0
Sequence II, mL, max, tendency/stability ^H	50/0	50/0
Sequence III, mL, max, tendency/stability ^H	10/0	10/0
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability/	100/0	100/0
ASTM D6922, homogeneity and miscibility	J	J
ASTM D6709, (Sequence VIII) shear stability	κ	к
ASTM D7097 (TEOST MHT), high-temperature deposits, deposit mass, mg, max ^F	35	45
ASTM D5133, gelation index, max	12 ^L	NR
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150 °C mPa·s, min	NR	2.6

^A Tests are per ASTM requirements.

^B Does not include SAE 0W-16 and SAE 5W-16.

^c If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the "S" category and there is no API Certification Mark, the Sequence VG (ASTM D6593), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.

^D ASTM Surveillance Panel will review statistics annually.

^E Calculated conversions specified in ASTM D5800 are allowed.

^F For all viscosity grades: If CF-4, CG-4, and/or CI-4 categories precede the "S" category and there is no API Certification Mark, the limits for phosphorus, sulfur, and the TEOST MHT do not apply. However, the CJ-4 limits for phosphorous and sulfur do apply for CJ-4 oils. This footnote cannot be applied if CK-4 or FA-4 is also claimed. Note that these oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.

^G This is a non-critical specification as described in ASTM D3244.

^{*H*} After 10 min settling period.

¹ After 1 min settling period.

^J Shall remain homogeneous and, when mixed with ASTM reference oils, shall remain miscible.

K Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥5.6 mm²/s.

^L To be evaluated from –5 °C to temperature at which 40 000 cP is attained or –40 °C, or 2 °C below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

X7. REQUIREMENTS FOR API SERVICE CATEGORY SN AND API SN WITH RESOURCE CONSERVING AND API SN WITH SN PLUS

X7.1 See Table X7.1.

TABLE X7.1 Requirements for API Service Category SN and API SN with Resource Conserving, and API SN with SN Plus NOTE 1—All oils must meet the requirements of the most recent edition of SAE J300. NOTE 2—NR = Not required.

	API SN	API SN	API SN with Resource Conserving
	SAE 0W-16, SAE 5W-16, SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W-30	Other Viscosity Grades	All Viscosity Grades
Engine Test Requirements ⁴			
ASTM D7320, (Sequence IIIG)			
Kinematic viscosity increase @ 40 °C, %	150 (max)	150 (max)	150 (max)
Average weighted piston deposits, merits	4.0 (min)	4.0 (min)	4.0 (min)
Hot stuck rings	None	None	None
Average cam plus lifter wear, µm	60 (max)	60 (max)	60 (max)
OR			
ASTM D8111 (Sequence IIIH)			
Kinematic viscosity increase @ 40 °C, %	150 (max	150 (max)	150 (max)
Average weighted piston deposits, merits	3.7 (min)	3.7 (min)	3.7 (min)
Hot stuck rings	None	None	None
ASTM D6891, (Sequence IVA)			
Average cam wear (7 position avg), μm	90 (max)	90 (max)	90 (max)
ASTM D6593, (Sequence VG) ^B			
Average engine sludge, merits	8.0 (min)	8.0 (min)	8.0 (min)
Average rocker cover sludge, merits	8.3 (min)	8.3 (min)	8.3 (min)
Average engine varnish, merits	8.9 (min)	8.9 (min)	8.9 (min)
Average piston skirt varnish, merits	7.5 (min)	7.5 (min)	7.5 (min)
Oil screen sludge, % area	15 (max)	15 (max)	15 (max)
Oil screen debris, % area	Rate & report	Rate & report	Rate & report
Hot-stuck compression rings	None	None	None
Cold stuck rings	Rate & report	Rate & report	Rate & report
Oil ring clogging, % area	Rate & report	Rate & report	Rate & report
OR			
ASTM D8256 (Sequence VH)			
Average engine sludge, merits	7.6 (min)	7.6 (min)	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)	7.7 (min)	7.7 (min)
Average engine varnish, merits	8.6 (min)	8.6 (min)	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)	7.6 (min)	7.6 (min)
Oil screen clogging, % area	Rate & report	Rate & report	Rate & report
Hot stuck compression rings	None	None	None
ASTM <mark>D7589</mark> , (Sequence VID) ^c			
SAE XW-16 viscosity grade			
FEI SUM	NR	NR	2.8 % min
FEI 2			1.3 % min after 100 hours aging
SAE XW-20 viscosity grade			
FEI SUM			2.6 % min
FEI 2			1.2 % min after 100 hours aging
SAE XW-30 viscosity grade			
FEI SUM			1.9 % min
FEI 2			0.9 % min after 100 hours aging
SAE 10W-30 and all other viscosity grades not listed above			
FEI SUM			1.5 % min

FEI 2			0.6 % min after 100 hours aging		
OR					
ASTM D8114 (Sequence VIE) ⁸					
SAE XW-20 viscosity grade					
FEI SUM			3.2 % min		
FEI 2			1.5 % min after 100 hours aging		
SAE XW-30 viscosity grade					
FEI SUM			2.5 % min		
FEI 2			1.2 % min after 100 hours aging		
SAE 10W-30 and all other viscosity grades not listed above					
FEI SUM			2.2 % min		
FEI 2			1.0 % min after 100 hours aging		
ASTM D8226 (Sequence VIF)					
SAE XW-16 viscosity grade					
FEI SUM			3.7 % min		
FEI 2			1.8 % min after 100 hours aging		
ASTM D6709, (Sequence VIII)					
Bearing weight loss, mg	26 (max)	26 (max)	26 (max)		
ASTM D8291 (Sequence IX) ^H					
Average number of events	5 (max) ⁰	5 (max) ^D	5 (max) ^D		
Bench Test and Measured Parameter ^A	1	T			
Aged oil low-temperature viscosity					
ASTM D4684, (Sequence IIIGA), aged oil low-temperature viscosity ^E	a) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at MRV temperature specified in SAE J300 for original viscosity grade.				
	b) If CCS viscosity measured is higher than maximum viscosity specified for original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade)				
	c) EOT IIIGA sample must show n maximum specified in SAE J300 for CCS visc	o yield stress in D4684 to original viscosity grade c osity grade, as outlined i	est and its D4684 viscosity must be below or next higher viscosity grade, depending on n a) or b) above.		
OR					
ASTM D7528, (ROBO Test), aged oil low temperature viscosity ^E	d) If CCS viscosity measured is less the grade, run ASTM D4684 (MRV TP-1	han or equal to maximum) at the MRV temperature grade.	CCS viscosity specified for original viscosity e specified in SAE J300 for original viscosity		
	e) If CCS viscosity measured is higher run ASTM D4684 (MRV TP-1) at 5 °C	r than maximum viscosity C higher temperature (i.e. for next higher viscosity	/ specified for original viscosity grade in J300, , at MRV temperature specified in SAE J300 grade).		
	 f) EOT ROBO sample must show r maximum specified in SAE J300 for CCS visc 	no yield stress in D4684 t original viscosity grade c cosity grade, as outlined i	est and its D4684 viscosity must be below or next higher viscosity grade, depending on n a) or b) above.		
ASTM D7320, (Sequence IIIGB) phosphorus retention, % min	NR	NR	79		
OR					
ASTM D8111, (Sequence IIIHB) phosphorous retention, % min	NR	NR	81		
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150 °C, mPa·s, min	2.3	2.6	2.3		
ASTM D6557 (Ball Rust Test), avg. gray value, min ⁸	100	100	100		
ASTM D5800, evaporation loss, 1 hour at 250 °C, % max ^F	15	15	15		
ASTM D6417, simulated distillation at 371 °C, % max	10	10	10		
ASTM D6795, EOFT, % flow reduction, max	50	50	50		
ASTM D6794, EOWTT, % flow reduction, max					
with 0.6 % H ₂ O	50	50	50		
with 1.0 % H ₂ O	50	50	50		
with 2.0 % H ₂ O	50	50	50		
with 3.0 % H ₂ O	50	50	50		

ASTM D4951 or D5185, phosphorus % mass, max ^G		0.08 ^H		NR		0.08 ^H	
ASTM D4951 or D5185, phosphorus % mass, min ^G		0.06 ^H		0.06 ^H			0.06 ^H
ASTM D4951, D5185, or D2622, sulfur % mass, max ^G							
SAE 0W-16, 5W-16, 0W-20, 0W-30, 5W-20, and 5W-30		0.5 ⁶		NR			0.5 ^G
SAE 10W-30		0.6 ⁶		NR			0.6 ^G
All other viscosity grades		NR		NR			0.6 ⁶
ASTM D892 (Option A), foaming tendency							
Sequence I, mL, max, tendency/stability		10/0 [/]		10/0 ⁷			10/0 [/]
Sequence II, mL, max, tendency/stability		50/0 [/]		50/0 ^{./}			50/0 [/]
Sequence III, mL, max, tendency/stability		10/0 [/]		10/0 ^{./}			10/0 [/]
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability [/]		100/0		100/0			100/0
ASTM D6922, homogeneity and miscibility		К		К			К
ASTM D6709, (Sequence VIII) shear stability		L		L			L
ASTM D7097, TEOST MHT, high-temperature deposits, deposit wt, mg, max ^F		35		45			35
ASTM D5133, gelation index, max ^B		12 ^M		NR			12 ^M
ASTM D6335, TEOST 33C, high-temperature deposits, total deposit weight, mg, max							
SAE XW-16		NR		NR		NR	
SAE 0W-20		NR		NR			NR
All other viscosity grades		NR		NR			30
ASTM D7563, emulsion retention		NR		NR		no wate	er separation
ASTM D7216 Annex A2, elastomer compatibility			Car the defi to A	ndidate oil testing for e five Standard Refe ned in SAE J2643. (STM D7216 Annex shall conform	r elast rence Candio A2. T to the	omer compatibility s Elastomers (SREs date oil testing shall he post-candidate-c specification limits	shall be performed using) referenced herein and be performed according bil-immersion elastomers detailed below:
Elastomer Material (SAE J2643)		Test Procedure	Ν	/laterial Property		Units	Limits
		ASTM D471		Volume		%Δ	-5, 9
Polyacrylate Rubber (ACM-1)		ASTM D2240		Hardness		pts.	-10, 10
		ASTM D412	-	Tensile Strength		%Δ	-40, 40
		ASTM D471		Volume		% Δ	-5, 10
Hydrogenated Nitrile Rubber (HNBR-1)		ASTM D2240		Hardness		pts.	-10, 5
		ASTM D412	-	Tensile Strength		% Δ	-20, 15
		ASTM D471		Volume		% Δ	-5, 40
Silicone Rubber (VMQ-1)		ASTM D2240		Hardness		pts.	-30, 10
		ASTM D412	-	Tensile Strength		%Δ	-50, 5
		ASTM D471		Volume		% Δ	-2, 3
Fluorocarbon Rubber (FKM-1)		ASTM D2240		Hardness		pts.	-6, 6
		ASTM D412	-	Tensile Strength		%Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)		ASTM D471		Volume		%Δ	-5, 30
		ASTM D2240		Hardness		pts.	-20, 10
		ASTM D412	-	Tensile Strength		%Δ	-30, 30

^A Tests are per ASTM requirements.

^{*B*} If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the "S" category and there is no API Certification Mark, the Sequence VG (ASTM D6593) or Sequence VH (ASTM D8256), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.

^c Viscosity grades are limited to 0W, 5W and 10W multigrade oils.

^D Required only for oils claiming to meet API SN with SN PLUS or API SN with SN PLUS and Resource Conserving.

^E Not required for monograde and 15W, 20W, and 25W multigrade oils.

^F Calculated conversions specified in ASTM D5800 are allowed.

^G For all viscosity grades: If CH-4, CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the "S" category limits for phosphorus, sulfur, and the TEOST MHT do not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils. This footnote cannot be applied if CK-4 or FA-4 is also claimed. Note that these "C" category oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.

^{*H*} This is a non-critical specification as described in ASTM D3244.

[/] After 1 min settling period.

^J After 10 min settling period.

^{*K*} Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.

^L Ten hour stripped kinematic viscosity must remain in original SAE viscosity grade.

^M To be evaluated from -5 °C to temperature at which 40 000 cP is attained or -40 °C, or 2 °C below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

X7.2 SN PLUS Classification in Conjunction with API Service Category SN and API SN with Resource Conserving (See Table X7.2)

Performance Test	Performance Criteria			
Sequence VID (ASTM D7589) ⁴				
Viscosity Grade	FEI SUM	FEI 2 minimum after 100 hours aging		
XW-16 ⁸	2.8 % min	1.3 % min		
XW-20	2.6 % min	1.2 % min		
XW-30	1.9 % min	0.9 % min		
10W-30 and all other viscosity grades not listed above	1.5 % min	0.6 % min		
OR				
Sequence VIE (ASTM D8114) ⁴				
Viscosity Grade	FEI SUM	FEI 2 minimum after 100 hours aging		
XW-20	3.2 % min	1.5 % min		
XW-30	2.5 % min	1.2 % min		
10W-30 and all other viscosity grades not listed above	2.2 % min	1.0 % min		
Sequence VIF (ASTM D8226) ^A				
Viscosity Grade	FEI SUM	FEI 2 minimum after 100 hours aging		
XW-16 ⁸	3.7 % min	1.8 % min		
Sequence IIIGB (ASTM D7320)	79 % phosphorus retention min			
OR				
Sequence IIIHB (ASTM D8111)	81 % phosphorus retention min			
Emulsion Retention (ASTM D7563)	No water separation			
High Temperature Deposits, TEOST 33C (ASTM D6335), Total Deposit Weight, mg				
SAE XW-16, 0W-20	Not Required			
All other viscosity grades	30 max			

TABLE X7.2 Resource Conserving Primary Performance Criteria with API Service Category SN

^A Viscosity grades are limited to 0W, 5W and 10W multi-grade oils.
 ^B Resource Conserving does not apply to 5W-16.

X8. REQUIREMENTS FOR API SERVICE CATEGORY SP-2020 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

X8.1 (See Table X8.1)

TABLE X8.1 Requirements for API Service Category SP and API SP with Resource Conserving NOTE 1—All oils must meet the requirements of the most recent edition of SAE J300. NOTE 2—NR = Not required.

		API SP	API SP	API SP with Resource Conserving
		SAE 0W-16, SAE 5W- 16, SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W- 30	Other Viscosity Grades	All Viscosity Grades
Engine Test Requirements ^A		-		
ASTM D8111 (Sequence IIIH)				
Kinematic viscosity increase @ 40 °C, %, max		100	100	100
Average weighted piston deposits, merits, min		4.2	4.2	4.2
Hot stuck rings		None	None	None
ASTM D8350 (Sequence IVB)				
Average intake lifter volume loss (8 position avg), mm ³ , ma	Х	2.7	2.7	2.7
End of test iron, ppm, max		400	400	400
ASTM D8256 (Sequence VH) ^B				
Average engine sludge, merits, min		7.6	7.6	7.6
Average rocker cover sludge, merits, min		7.7	7.7	7.7
Average engine varnish, merits, min		8.6	8.6	8.6
Average piston skirt varnish, merits, min		7.6	7.6	7.6
Oil screen sludge, % area		Rate & report	Rate & report	Rate & report
Oil screen debris, % area		Rate & report	Rate & report	Rate & report
Hot-stuck compression rings		None	None	None
Cold stuck rings		Rate & report	Rate & report	Rate & report
Oil ring clogging, % area		Rate & report	Rate & report	Rate & report
ASTM D8114 (Sequence VIE) ^C				
SAE XW-20 viscosity grade				
FEI SUM, % min				3.8
FEI 2, % min after 125 hours aging				1.8
SAE XW-30 viscosity grade				
FEI SUM, % min				3.1
FEI 2, % min after 125 hours aging				1.5
SAE 10W-30 and all other viscosity grades not listed above	9			
FEI SUM, % min				2.8
FEI 2, % min after 125 hours aging				1.3
ASTM D8226 (Sequence VIF)				
SAE XW-16 viscosity grade				
FEI SUM, % min				4.1
FEI 2, % min after 125 hours aging				1.9
ASIM D6709 (Sequence VIII)				
Bearing weight loss, mg, max				
SAE XW-16		NR	NR	NR
All other viscosity grades		26	26	26
ASTM D8291 (Sequence IX)		_		
Average number of events for four iterations, max		5	5	5
Number of events per iteration, max		8	8	8
ASTM D8279 (Sequence X)				
% increase, max		0.085	0.085	0.085
Bench Test and Measured Parameter ^A				

		API SP	API SP	API SP with Resource Conserving
		SAE 0W-16, SAE 5W- 16, SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W- 30	Other Viscosity Grades	All Viscosity Grades
Aged oil low-temperature viscosity				
ASTM D8111, (Sequence IIIHA), aged oil lowtemperature v	iscosity ^D	a) If CCS viscosity m viscosity specified for TP-1) at MRV tempera	easured is less than or ea original viscosity grade, r ature specified in SAE J3 grade.	qual to maximum CCS un ASTM <mark>D4684</mark> (MRV 00 for original viscosity
Measure aged oil low temperature viscosity on final formula read across described in Annex F)—this includes base oil a being licensed—for each viscosity grade by either IIIHA or F	ition (pursuant to existing ind additive combination ROBO	b) If CCS viscosity mea for the original viscosity 5 °C higher temperature for	sured is higher than max / grade in J300, run ASTI e (i.e., at MRV temperatur next higher viscosity gra	imum viscosity specified M D4684 (MRV TP-1) at re specified in SAE J300 de).
Measure CCS viscosity of EOT IIIHA sample at CCS tempe corresponding to original viscosity grade	erature	c) EOT Seq. IIIHA samp D4684 viscosity mus original viscosity grade viscosity g	le must show no yield str t be below maximum spe or next higher viscosity g grade, as outlined in a) or	ess in D4684 test and its cified in SAE J300 for rade, depending on CCS b) above.
OR				
ASTM D7528, (ROBO Test), aged oil low-temperature visco	osity ^D	d) If CCS viscosity me viscosity specified for TP-1) at MRV tempera	easured is less than or eo original viscosity grade, r ature specified in SAE J3 grade.	qual to maximum CCS un ASTM <mark>D4684</mark> (MRV 00 for original viscosity
Measure aged oil low temperature viscosity on final formula read across described in Annex F)—this includes base oil a being licensed—for each viscosity grade by either IIIHA or F	ition (pursuant to existing ind additive combination ROBO	e) If CCS viscosity mea for original viscosity gra higher temperature (i.e n	sured is higher than max de in J300, run ASTM D4 ., at MRV temperature sp ext higher viscosity grade	imum viscosity specified 1684 (MRV TP-1) at 5 °C becified in SAE J300 for e).
Measure CCS viscosity of ROBO sample at CCS temperatu corresponding to original viscosity grade	f) EOT ROBO sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in d) or e) above.			
ASTM D8111, (Sequence IIIHB) phosphorus retention, % min		NR	NR	81
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150 °C, mPa·s, min		2.3	2.3	2.3
ASTM D6557 (Ball Rust Test), avg. gray value, min ⁸		100	100	100
ASTM D5800, evaporation loss, 1 hour at 250 °C, % max ^E		15.0	15.0	15.0
ASTM D6795, EOFT, % flow reduction, max		50	50	50
ASTM D6794, EOWTT, % flow reduction, max				
with 0.6 % H ₂ O		50	50	50
with 1.0 % H ₂ O		50	50	50
with 2.0 % H ₂ O		50	50	50
with 3.0 % H ₂ O		50	50	50
ASTM D4951 or D5185, phosphorus % mass, max ^F		0.08 ^G	NR	0.08 ⁶
ASTM D4951 or D5185, phosphorus % mass, min ^F		0.06 ^G	0.06 ⁶	0.06 ⁶
ASTM D4951, D5185, or D2622, sulfur % mass, max ^F				
SAE 0W-16, 5W-16, 0W-20, 0W-30, 5W-20, and 5W-30		0.5 ^F	NR	0.5 ^F
SAE 10W-30		0.6 ^F	NR	0.6 ^F
All other viscosity grades		NR	NR	0.6 ^F
ASTM D892 (Option A and excluding paragraph 11), foaming	tendency			
Sequence I, mL, max, tendency/stability		10/0 ^H	10/0′	10/0 ^H
Sequence II, mL, max, tendency/stability		50/0 ^H	50/0 [/]	50/0 ^H
Sequence III, mL, max, tendency/stability		10/0 ^H	10/0/	10/0 ^H
D6082 (Option A), high-temperature foaming mL, max, tender	ncy/stability ^H	100/0	100/0	100/0
ASTM D6922, homogeneity and miscibility		J	J	J
ASTM D6709, (Sequence VIII) shear stability				
SAE XW-16		NR	NR	NR
All other viscosity grades	<u> </u>	Stay in grade ^r	Stay in grade ^ĸ	Stay in grade ^ĸ
AS I M DOZ/8, (Diesel Injector) shear stability, KV @ 100 °C a	iter 30 passes, min	E 0	5 0	F 0
		5.8	5.8	5.8
All other viscosity grades				
ASTM DO100, getation index, max	lenosit weight ma may	12-	NK	12-
AS THE DOSSO, TEOST 350, High-temperature deposits, total of	aeposit weight, mg, max			

		API SP	API SP	API SP with Resource Conserving
		SAE 0W-16, SAE 5W- 16, SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W- 30	Other Viscosity Grades	All Viscosity Grades
SAE XW-16		NR	NR	NR
SAE 0W-20		NR	NR	NR
All other viscosity grades		NR	NR	30
ASTM D7563, emulsion retention		NR	NR	no water separation
ASTM D7216 Annex A2, elastomer compatibility		Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2. The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed below:		
Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

^A Tests are per ASTM requirements.

^B If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the "S" category and there is no API Certification Mark, the Sequence VH (ASTM D8256), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.

^c Viscosity grades are limited to 0W, 5W, and 10W multi-grade oils.

^D Not required for monograde and 15W, 20w, and 25W multi-grade oils.

^E Calculated conversions specified in ASTM D5800 are allowed.

^F For all viscosity grades: If CH-4, CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the "S" category limits for phosphorus and sulfur do not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils, and the phosphorous limit in the "SP with Resource Conserving" column (0.08 % mass maximum) applies when CK-4 with SP or FA-4 with SP is claimed. Note that these "C" category oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.

^G This is a non-critical specification as described in ASTM D3244.

^{*H*} After 1-minute setting period.

[/] After 10-minute setting period.

^J Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.

^{*K*} Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade.

^L To be evaluated from –5 °C to temperature at which 40 000 cP is attained or –40 °C, or 2 °C below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

Performance Test	Performance Criteria	
	FEI SUM	FEI 2 minimum after 125 hours aging
Sequence VIE (ASTM D8114) ⁴		
Viscosity Grade		
XW-20	3.8 %	1.8 %
XW-30	3.1 %	1.5 %
10W-30 and all other viscosity grades not listed above	2.8 %	1.3 %
Sequence VIF (ASTM D8226) ^A		
Viscosity Grade		
XW-16	4.1 %	1.9 %
Sequence IIIHB (ASTM D8111)	81 % phosphorous retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits, TEOST 33C (ASTM D6335), Total Deposit Weight, mg		
SAE XW-16, 0W-20	Not Required	
All other viscosity grades	30 max	

	FABLE X8.2 Resource Conserving Primary	Performance Criteria with API Service Category SP
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^A Viscosity grades are limited to 0W, 5W, and 10W multigrade oils.