A Program of ASTM International

Test Monitoring Center

203 Armstrong Drive, Freeport, PA 16229, USA

www.astmtmc.org
412-365-1000

D4485 Information Letter 22-1
Sequence Number 15
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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The SJ Category section contained several references to obsolete tests that have been superseded by newer versions (4.1.1.2, 4.1.1.3). The SL Category section contained several references to obsolete tests that have been superseded by newer versions (4.1.2.1, 4.1.2.4). The CH-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.3.7). The CI-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.4.5) The CJ-4 Category section contained a reference to obsolete tests that have been superseded by newer versions (4.1.4.7).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.

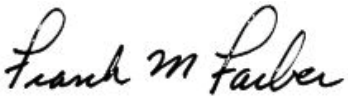
Numerous erroneous section references in the Appendixes were corrected in this process. Due to the extensive revisions done to the Appendixes, a full replacement version is included to help insure the

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

Frank M. Farber
Director
Test Monitoring Center

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

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

	API SJ Category			
Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria
Sequence IID (D5844[A,B]) or D6557[A] (Ball Rust Test)	D5844	Average engine rust rating,[C] min Number stuck lifters		8.5 none
	D6557	Average gray value, min		100
Sequence IIIE (D5533[B,D]) or Sequence IIIF (D6984[D]) or Sequence IIIG (D7320[J]) Sequence IIIH (D8111[AE]using Appendix X5 IIIH70 hour guideline)	D5533	Hours to 375 % kinematic viscosity increase at 40 °C, min		64
		Average engine sludge rating,[C] min		9.2
		Average piston skirt varnish rating,[C] min		8.9
		Average oil ring land deposit rating,[C] min		3.5
		Lifter sticking		none
		Scuffing and wear		
		Cam or lifter scuffing		none
		Cam plus lifter wear, µm	Average, max	30
			Maximum, max	64
		Ring sticking (oil-related)[E]		none
	D6984	Kinematic viscosity, % increase at 40 °C, max		325[F]
		Average piston skirt varnish rating,[C] min		8.5[G]
		Weighted piston deposit rating,[H] min		3.2[G]
		Screened average cam-plus–lifter wear, µm, max		20[G,I]
		Hot stuck rings		none[G]
	D7320	Kinematic viscosity, % increase at 40 °C, max		150
		Weighted piston deposit rating,[K] min		3.5
		Cam-plus-lifter wear avg, µm, max		60
		Hot stuck rings		none
	D8111(Using Appendix X5 IIIH70 hour guideline)	60 h kinematic viscosity, % increase at 40 °C, max		307
		70 h average weighted piston deposits,[H] merits, min		2.5
		70 h average piston skirt varnish,[C] merits, min		7.5
Sequence VE (D5302[B,L]) or Sequence IVA (D6891[L]) plus Sequence VG (D6593[L]) or Sequence IVA (D6891[L]) plus Sequence VH (D8256[L])	D5302	Average engine sludge rating,[C] min		9.0
		Rocker arm cover sludge rating,[C] min		7.0
		Average piston skirt varnish rating,[C] min		6.5
		Average engine varnish rating,[C] min		5.0
		Oil ring clogging, %		report
		Oil screen clogging, %, max		20.0
		Compression ring sticking (hot stuck)		none
		Cam wear, µm	Average, max	127
			Maximum, max	380
	D6891	Average cam wear, µm[M]		120
	D6593	Average engine sludge rating,[C] min		7.8
		Rocker arm cover sludge rating,[C] min		8.0
		Average piston skirt varnish rating,[C] min		7.5
		Average engine varnish rating,[N] min		8.9
		Oil screen clogging, %, max		20
		Hot stuck compression rings		none
	D8256	Average engine sludge, merits, min		7.4
		Average rocker cover sludge, merits, min		7.4
		Average engine varnish, merits, min		8.6
		Average piston skirt varnish, merits, min		7.4
		Oil screen clogging, % area		Rate & Report
		Hot stuck compression rings		None
L-38 (D5119[O]) or Sequece VIII (D6709[O])	D5119	Bearing weight loss, mg, max		40
		Shear stability		[P]
	D6709	Bearing weight loss, mg, max		26.4
		Shear stability		[P]

Bench Test and Measured Parameter	Viscosity Grade Performance Criteria		
	SAE 0W-20, SAE 5W-20, SAE 5W-30, SAE 10W-30		All Others
Test Method D4683, D4741, D5481, high temperature/high shear viscosity @ 150 °C, mPa·s, min	[Q]		2.6
Test Method D5800 volatility loss, % max[R]	22		20[S]
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 D6795 (EOFT), % flow reduction, max	50		50
Test Method D6794 (EOWTT), % flow reduction, max	with 0.6 % H_20	report	report
	with 1.0 % H_20	report	report
	with 2.0 % H_20	report	report
	with 3.0 % H_20	report	report
Test Method D4951 or D5185, mass fraction phosphorus, %, max	0.10[T]		NR[U]
Test Method D4951 or D5185, mass fraction phosphorus, %, min (unless valid passing Test Method D5302 results are obtained)	0.06		0.06
Test Method D92 flash point, °C, min[V]	200		NR[U]
Test Methods D93 or D7094 flash point, °C, min[V]	185		NR[U]
Test Method D892 foaming tendency (Option A)	Sequence I, max, foaming/settling[W]	10/0	10/0
	Sequence II, max, foaming/settling[W]	50/0	50/0
	Sequence III, max, foaming/settling[W]	10/0	10/0
Test Method D6082 (optional blending required) Static foam, max, tendency/stability		200/50[X]	200/50[X]
Test Method D6922 homogeneity and miscibility		[Y]	[Y]
Test Method D6335 High temperature deposits (TEOST 33), deposit mass, mg, max		60	60
Test Method D5133 Gelation Index, 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 Performance Criteria
Sequence IIIF (D6984) or Sequence IIIG (D7320[J]) or Sequence IIIH (D8111[AE] using Appendix X5 IIIH70 hour guideline)	D6984	Kinematic viscosity, % increase at 40 °C, max	275
		Average piston skirt varnish rating,[C] min	9.0
		Weighted piston deposit rating, [H] min	4.0
		Screened average cam-plus-lifter wear, µm, max	20[I]
		Hot Stuck Rings	none
		Low temperature viscosity performance[Z]	report
	D7320	Kinematic viscosity, % increase at 40 °C, max	150
		Weighted piston deposit rating,[K] min	3.5
		Cam-plus-lifter wear avg, µm, max	60
		Hot stuck rings	none
		Low temperature viscosity performance[AA]	report
	D8111 (Using Appendix X5 IIIH70 hour guideline)	70 h kinematic viscosity, % increase at 40 °C, max	181
		70 h average weighted piston deposits, merits, min	3.3
		70 h average piston skirt varnish,[C] merits, min	7.9
Sequence IVA (D6891)	D6891	Cam wear average, µm,[M] max	120
Sequence VE (D5302[AB,J])	D5302	Cam wear average, µm, max	127
		Cam wear max, µm, max	380
Sequence VG (D6593) or Sequence VH (D8256)	D6593	Average engine sludge rating,[C] min	7.8
		Rocker arm cover sludge rating,[C] min	8.0
		Average piston skirt varnish rating,[C] min	7.5
		Average engine varnish rating,[N] min	8.9
		Oil screen clogging, %, max	20
		Hot stuck Compression rings	none
		Cold stuck rings	report
		Oil screen debris, %	report
		Oil ring clogging, %	report
	D8256	Average engine sludge, merits, min	7.4
		Average rocker cover sludge, merits, min	7.4
		Average engine varnish, merits, min	8.6
		Average piston skirt varnish, merits, min	7.4
		Oil screen clogging, % area	Rate & Report
		Hot stuck compression rings	None
Sequence VIII (D6709)	D6709	Bearing weight loss, mg, max	26.4
		Shear stability	[P]

Bench Test and Measured Parameter		Viscosity Grade Performance Criteria	
		SAE 0W-20 SAE 5W-20 SAE 5W-30 SAE 10W-30	All Others
Test Method D4683, D4741, or D5481, high temperature/high shear viscosity @ 150 °C, mPa·s, min		[Q]	2.6
Test Method D6557 (Ball Rust Test), average gray value, min		100	100
Test Method D5800 volatility loss, % max		15	15
Test Method D6417 volatility loss at 371 °C, % max		10	10
D6795 (EOFT), % flow reduction, max		50	50
D6794 (EOWTT), % flow reduction, max	With 0.6 % H_2O	50	50
	With 1.0 % H_2O	50	50
	With 2.0 % H_2O	50	50
	With 3.0 % H_2O	50	50
Test Method D4951 or D5185, mass fraction phosphorus %, max		0.10[T]	NR[U]
Test Method D4951 or D5185, mass fraction phosphorus %, min (unless valid passing Test Method D5302 results are obtained)[J]		0.06	0.06
Test Method D892 foaming tendency (Option A)	Sequence I, max, foaming/settling[W]	10/0	10/0
	Sequence II, max, foaming/settling[W]	50/0	50/0
	Sequence III, max, foaming/settling[W]	10/0	10/0
Test Method D6082 (optional blending required) static foam max, tendency/stability		100/0[X]	100/0[X]
Test Method D6922 homogeneity and miscibility		[Y]	[Y]
Test Method D7097 high temperature deposits (TEOST MHT-4), deposit mass, mg, max		45	45
Test Method D5133 (Gelation Index), 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.

[D] Demonstrate 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 [J]).

[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.

[I] 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).

[Q] 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.

TABLE 2 Diesel Engine Oil Category CH-4

Required Test Method	Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
1P (D6681[B])	D6681	Weighted demerits (WDP), max		350	378	390
		Top groove carbon (TGC), demerits, max		36	39	41
		Top land carbon (TLC), demerits, max		40	46	49
		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 scuffing		none	none	none[C]
1K (D6750[D])	D6750	Weighted demerits (WDK), %, max		332	347	353
		Top groove fill (TGF), %, max		24	27	29
		Top land heavy carbon (TLHC), %, max		4	5	5
		Average Oil Consumption	g/kWh (0 h – 252 h), max	0.54	0.54	0.54
			g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none[C]
T-9 (D6483) or T-10 (D6987/D6987M) or T-12 (D7422)	D6483	Average Liner Wear, normalized to 1.75 % soot, µm max		25.4	26.6	27.1
		Average Top Ring Mass Loss, mg max[E]		120	136	144
		EOT Used Oil Lead Content less New Oil Lead Content, mg/kg, max		25	32	36
	D6987/D6987M	Liner wear, µm, max		32	34	35
		Ring wear, mg, max		150	159	163
		Lead content at EOT, mg/kg, max		50	56	59
	D7422	Liner wear, µm, max		30.0	30.8	31.1
		Top Ring Mass Loss, mg, max		120	132	137
		Lead content at EOT, mg/kg, max		65	75	79
RFWT (D5966)	D5966	Average Pin Wear	mils, max	0.30	0.33	0.36
			(µm) max	(7.6)	(8.4)	(9.1)
M11 (D6838[F]) or ISM (D7468)	D6838	Rocker Pad Average Mass Loss, normalized to 4.5 % soot, mg max		6.5	7.5	8.0
		Oil Filter Differential Pressure at EOT, kPa max		79	93	100
		Average Engine Sludge, CRC Merits at EOT, min		8.7	8.6	8.5
	D7468	Crosshead wear, mg, max		7.5	7.8	7.9
		Oil filter delta pressure, at 150 h, kPa, max		79	95	103
		Sludge rating, CRC merits, min		8.1	8.0	8.0
Ext. T-8E (D5967[G])	D5967	Relative Viscosity at 4.8 % Soot by TGA, max		2.1	2.2	2.3
		Viscosity increase at 3.8 % Soot by TGA, mm^2/s, max		11.5	12.5	13.0
Sequence IIIF (D6984) or Sequence IIIG (D7320[I]) or Sequence IIIH (D8111 using IIIH60 Appendix X4)	D6984	60 h Viscosity at 40 °C, increase from 10 min sample, % max		295	295 (MTAC)[H]	295 (MTAC)[H]
	D7320	Kinematic viscosity, % increase at 40 °C max		150	150 (MTAC)	150 (MTAC)
	D8111 (IIIH60 Appendix X4)	60 h Kinematic viscosity, % increase at 40 °C max		249	249 (MTAC)	249 (MTAC)
EOAT (D6894[J])	D6894	Aeration, volume, % max		8.0	8.0 (MTAC)[H]	8.0 (MTAC)[H]
CH-4 Bench Tests		Measured Parameter		Primary Performance Criteria		
HTCBT, 135 °C (D6594)	D6594	Used Oil Elemental Concentration				
		Copper, mg/kg increase, max		20		
		Lead, mg/kg increase, max		120		
		Tin, mg/kg increase		report		
		Copper strip rating,[K] max		3		
D892 (Option A not allowed)	D892 (Option A not allowed)	Foaming/Settling,[L] mL, max				
		Sequence I		10/0		
		Sequence II		20/0		
		Sequence III		10/0		
Noack (D5800) or D6417				SAE 10W-30	SAE 15W-40	
	D5800	percent volatility loss at 250 °C, max		20	18	
	D6417	percent volatility loss at 371 °C, max		17	15	
D6278	D6278	Kinematic Viscosity after shearing, mm^2/s at 100 °C, min		SAE XW-30	SAE XW-40	
				9.3	12.5	

[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.

[G] A passing T-11 (TGA % soot at 12.0 mm^2/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.

[K] 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	Rated or Measured Parameter	Primary Performance Criteria		
			One-test	Two-test[A]	Three-test[A]
1R (D6923) or 1P (D6681)	D6923	Weighted demerits (WDR), max	382	396	402
		Top groove carbon (TGC), demerits, max	52	57	59
		Top land carbon (TLC), demerits, max	31	35	36
		Initial oil consumption (IOC), (0 h – 252 h), g/h, average	13.1	13.1	13.1
		Final oil consumption,(432 h – 504 h), g/h, average, max	IOC + 1.8	IOC + 1.8	IOC + 1.8
		Piston, ring, and liner distress	none	none	none
		Ring sticking	none	none	none
	D6681	Weighted demerits (WDP), max	350	378	390
		Top groove carbon (TGC), demerits, max	36	39	41
		Top land carbon (TLC), demerits, max	40	46	49
		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 scuffing	none	none	none
T-10 (D6987/D6987M) or T-12 (D7422)	D6987/D6987M	Merit rating,[A] min	1000	1000	1000
	D7422	Merit rating,[A] min	1000	1000	1000
M11 EGR (D6975) or ISM (D7468)	D6975	Average crosshead mass. loss, mg, max	20.0	21.8	22.6
		Average top ring mass loss, mg	report	report	report
		Oil filter differential pressure at 250 h, kPa, max	275	320	341
		Average engine sludge, CRC merits at EOT, min	7.8	7.6	7.5
	D7468	Crosshead wear, mg, max	7.5	7.8	7.9
		Oil filter Δ pressure at 150 h, kPa, max	55	67	74
		Sludge rating, CRC Merits, min	8.1	8.0	8.0
Ext. T-8E (D5967)[B]	D5967	Relative viscosity at 4.8 % soot[C]	1.8	1.9	2.0
Sequence IIIF (D6984)[D] or Sequence IIIG (D7320)[E] or Sequence IIIH (D8111) or Sequence IIIH70 (D8111 using Appendix X5)	D6984	Kinematic viscosity (at 40 °C), percent increase, max	275	275 (MTAC)	275 (MTAC)
	D7320	Kinematic viscosity, percent increase at 40 °C max	150	150 (MTAC)	150 (MTAC)
	D8111	60 – 80 h[F] Kinematic viscosity, % increase at 40 °C max	370	370 (MTAC)	370 (MTAC)
	D8111 (Using IIIH70 Appendix X5 guideline)	70 h Kinematic viscosity, % increase at 40 °C max	181	181 (MTAC)	181 (MTAC)
1K (D6750)[G]	D6750	Weighted demerits (WDK), max	332	347	353
		Top groove fill (TGF), %, max	24	27	29
		Top land heavy carbon (TLHC), %, max	4	5	5
		Average oil consumption g/kWh (0 h – 252 h), max	0.54	0.54	0.54
		Average oil consumption g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing	none	none	none
RFWT (D5966)	D5966	Average pin wear mils, max	0.30	0.33	0.36
		Average pin wear µm, max	7.6	8.4	9.1
EOAT (D6894)[H]	D6894	Aeration, volume percent, max	8.0	8.0 (MTAC)[I]	8.0 (MTAC)[I]

CI-4 Bench Tests	Measured Parameter	Primary Performance Criteria	
D4683 or D4741 or D5481[J]	High temperature/high shear viscosity at 150 °C[K], min	3.5 mPa-s	
MRV-TP-1 (D4684)	The following limits are applied to SAE viscosity grades 0W, 5W, 10W, and 15W: Viscosity of 75 h used oil sample from T-10 test (or T-10A[L] test), or 100 h used oil sample from T-12 test (or T-12A[M] test, tested at –20 °C, mPa-s, max	25 000	
	If yield stress is detected, use modified D4684[N] (external preheat), then mPa-s, max	25 000	
	and yield stress, Pa	<35	
Noack (D5800)	Evaporative loss at 250 °C, %, max	15	
135 °C HTCBT (D6594)	Copper, mg/kg increase, max	20	
	Lead, mg/kg increase, max	120	
	Tin, mg/kg increase	report	
	Copper strip rating,[O] max	3	
D6278	Kinematic viscosity after shearing mm²/s at 100 °C, min	SAE XW-30	SAE XW-40
		9.3	12.5
D892 (Option A not allowed)	Foaming/settling,[P] mL, max		
	Sequence I	10/0	
	Sequence II	20/0	
	Sequence III	10/0	

D7216 (Elastomer Compatibility)

Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.

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 designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends 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.

[F] 60 – 80 h value is interpolated according to the equation $$PVIS@(60-80)h = \left(\frac{\sqrt{PVIS@60\,h} + \sqrt{PVIS@80\,h}}{2} \right)^2$$, where PVIS@60 h is 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.

[O] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.

[P] Ten minutes for Sequence I, II, and III.

TABLE 4 Diesel Engine Oil Category CJ-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test	Three-test
T-12 (D7422)	D7422	Merit rating,[A] min		1000	1000	1000
ISM (D7468)	D7468	Merit rating,[A] min		1000	1000	1000
		Top ring mass loss, mg, max		100	100	100
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
		Hot-stuck piston ring		none	none	none
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		report	report	report
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h – 252 h), max	0.54	0.54)	0.54
			g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			µm, max	(7.6)	(8.4)	(9.1)
Sequence IIIF (D6984) or Sequence IIIG (D7320)[B] or Sequence IIIH (D8111) or Sequence IIIH70 (D8111 using Appendix X5)	D6984	Kinematic viscosity (at 40 °C), % increase, max		275	275 (MTAC)	275 (MTAC)
	D7320	Kinematic viscosity (at 40 °C), % increase, max		150	150 (MTAC)	150 (MTAC)
	D8111	60 – 80 h[C] Kinematic viscosity, % increase at 40 °C max		370	370 (MTAC)	370 (MTAC)
	D8111(Using IIIH70 Appendix X5 guideline)	70 h Kinematic viscosity, % increase at 40 °C max		181	181 (MTAC)	181 (MTAC)
EOAT (D6894)	D6894	Aeration, volume, %, max		8.0	8.0 (MTAC)	8.0 (MTAC)

Bench Test Methods	Measured Parameter	Primary Performance Criteria	
D4683 or D4171 or D5481	High temperature/high shear viscosity at 150 °C, min	3.5 mPa-s	
HTCBT, 135 °C (D6594)	Copper, mg/kg increase, max	20	
	Lead, mg/kg increase, max	120	
	Copper strip rating,[D] max	3	
D7109	Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min	SAE XW-30	SAE XW-40
		9.3	12.5
Noack (D5800)	Evaporative loss at 250 °C, %, max	SAE < > 10W-30	SAE 10W-30
		13	15
Foam (D892)	Foaming/settling,[E] mL, max		
	Sequence I	10/0	
	Sequence II	20/0	
	Sequence III	10/0	
MRV TP-1 (D6896)	Viscosity of the 180 h used oil drain sample from a T-11 test, tested at –20 °C, mPa-s, max	25 000	
	If yield stress is detected, use the modified test method (external preheat), then measure the viscosity, mPa-s, max	25 000	
	Measure the yield stress, Pa	<35	

Chemical Limits (non-critical)

Bench Test Methods	Measured Parameter	Primary Performance Criteria
D874	Mass fraction sulfated ash, %, max	1.0
D4951	Mass fraction phosphorus, %, max	0.12
	Mass fraction sulfur, %, max	0.4

D7216 (Elastomer Compatibility)

Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.

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)
Vamac G	(+TMC 1006, -3)	(+5, -TMC 1006)	(+10, -TMC 1006)	(+10, -TMC 1006)

Note—TMC 1006 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC 1006.

[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.

[C] 60 – 80 h value is interpolated according to the equation $$PVIS@(60-80)h = \left(\frac{\sqrt{PVIS@60\ h} + \sqrt{PVIS@80\ h}}{2}\right)^2$$, where PVIS@60 h is percent viscosity increase at 60 h and PVIS@80 h is percent viscosity increase at 80 h.

[D] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.

[E] Ten minutes for Sequence I, II, and III.

TABLE 5 Diesel Engine Oil Category CK-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
T-12 (D7422)	D7422	Top Ring Mass Loss, mg, max		105	105	105
		Cylinder Liner Wear, µm, max		24.0	24.0	24.0
T-13 (D8048)	D8048	IR Peak at EOT, Abs., cm^{-1}		125	130	133
		Kinematic Viscosity Increase at 40 °C, % max		75	85	90
		Avg. Oil Consumption, 48 h to 192 h, g/h, max		Report	Report	Report
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
COAT (D8047)	D8047	Average Aeration,[A] 40 h to 50 h, %		11.8	11.8	11.8
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		Report	Report	Report
ISM (D7468)	D7468	Top Ring Mass Loss, mg, max		100	100	100
		Merit Rating, [A]		1000	1000	1000
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h to 252 h), max	0.54	0.54	0.54
			g/MJ (0 h to 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			µm, max	(7.6)	(8.4)	(9.1)

CK-4 Category Bench Tests

Test Method	Measured Parameter		Primary Performance Criteria		
	SAE J300 Viscosity Grade		SAE xW-30	SAE xW-40	
D4683 or D4741 or D5481	High temperature/high shear viscosity at 150 °C, mPa·s	min	3.5	Meets SAE J300	
		max	N/A		
HTCBT, 135 °C (D6594)	Copper, mg/kg increase, max		20	20	
	Lead, mg/kg increase, max		120	120	
	Copper strip rating,[B] max		3	3	
Noack (D5800)	Evaporative loss at 250 °C, %, max		13	13	
Foam (D892)	Foaming/settling,[C] Sequence I, mL, max		10/0	10/0	
	Foaming/settling,[C] Sequence II, mL, max		20/0	20/0	
	Foaming/settling,[C] Sequence III, mL, max		10/0	10/0	
D7109 and HTHS Viscosity after 90 pass shearing (see above methods)	Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min		xW-30	0W-40	Other xW-40
			9.3	12.5	12.8
	HTHS viscosity at 150 °C, mPa·s, min		3.4	N/A	N/A
Sooted Oil MRV TP-1 (D6896) (D7156 Engine test required)	Viscosity, 180 h used oil sample from a T-11/T-11A test, tested at –20 °C, mPa·s, max		25 000	25 000	
	Yield stress of the 180 h used oil sample above, Pa max		≤35	≤35	

Chemical Limits (non-critical)

Test Method	Measured Parameter	Primary Performance Criteria
D874	Mass fraction sulfated ash, %, max	1.0
D4951	Mass fraction phosphorus, %, max	0.12
	Mass fraction sulfur, %, max	0.4

D7216 (Elastomer Compatibility)

Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.

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)
Vamac G	(+TMC 1006, –3)	(+5, –TMC 1006)	(+10, –TMC 1006)	(+10, –TMC 1006)

Note—TMC 1006 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC 1006.

[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.

TABLE 6 Diesel Engine Oil Category FA-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
T-12 (D7422)	D7422	Top Ring Mass Loss, mg, max		105	105	105
		Cylinder Liner Wear, µm, max		24.0	24.0	24.0
T-13 (D8048)	D8048	IR Peak at EOT, Abs., cm^{-1}		125	130	133
		Kinematic Viscosity Increase at 40 °C, % max		75	85	90
		Avg. Oil Consumption, 48 h to 192 h, g/h, max		Report	Report	Report
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
COAT (D8047)	D8047	Average Aeration,[A] 40 h to 50 h, %		11.8	11.8	11.8
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		Report	Report	Report
ISM (D7468)	D7468	Top Ring Mass Loss, mg, max		100	100	100
		Merit Rating, [A]		1000	1000	1000
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h to 252 h), max	0.54	0.54	0.54
			(g/MJ) (0 h to 252 h), max	(0.15)	(0.15)	(0.15)
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			(µm) max	(7.6)	(8.4)	(9.1)

FA-4 Category Bench Tests

Test Method	Measured Parameter		Primary Performance Criteria
D4683 or D4741 or D5481	SAE J300 Viscosity Grade		SAE xW-30
	High temperature/high shear viscosity at 150 °C, mPa·s	min	2.9
		max	3.2
HTCBT, 135 °F (D6594)	Copper, mg/kg increase, max		20
	Lead, mg/kg increase, max		120
	Copper strip rating,[B] max		3
Noack (D5800)	Evaporative loss at 250 °C, %, max		13
Foam (D892)	Foaming/settling,[C] Sequence I, mL, max		10/0
	Foaming/settling,[C] Sequence II, mL, max		20/0
	Foaming/settling,[C] Sequence III, mL, max		10/0
D7109 and HTHS Viscosity (see above methods) after 90 pass shearing	Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min		9.3
	HTHS Viscosity at 150 °C, mPa·s, min		2.8
Sooted Oil MRV TP-1 (D6896) (D7156 Engine test required)	Viscosity, 180 h used oil sample from a T-11/T-11A test, tested at –20 °C, mPa·s, max		25 000
	Yield stress of the 180 h used oil sample above, Pa max		≤35

Chemical Limits (non-critical)

Test Method	Measured Parameter	Primary Performance Criteria
D874	Mass fraction sulfated ash, %, max	1.0
D4951	Mass fraction phosphorus, %, max	0.12
	Mass fraction sulfur, %, max	0.4

D7216 (Elastomer Compatibility)

Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.

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)
Vamac G	(+TMC 1006, –3)	(+5, –TMC 1006)	(+10, –TMC 1006)	(+10, –TMC 1006)

Note—TMC 1006 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC 1006.

[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.

{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, 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:

TABLE X4.1 Multipliers

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

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

Requirement	Criterion
Fresh Oil Viscosity Requirements	
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
Gelation index	ASTM D5133
	12 (max)
	To be evaluated from –5 °C to temperature at which 40 000 cP is attained or –40 °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
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	
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 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	
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 multigrades, % (mass)	0.5 (max)
SAE 10W-30, % (mass)	0.6 (max
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_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	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)
Stability, mL, after 1-minute settling	0 (max)
Aged oil low temperature viscosity	ROBO (ASTM D7528)
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	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
Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to 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.
OR	
Aged oil low temperature viscosity	ASTM Sequence IIIHA (ASTM D8111)
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	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.
Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to 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, depending on the CCS viscosity grade, as outlined in a) or b) above.
Shear stability	ASTM Sequence VIII (ASTM D6709)
10-hour stripped KV @ 100 °C	
XW-20	Stay in grade
XW-30	Stay in grade
Homogeneity and miscibility	ASTM D6922

Requirement			Criterion	
			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 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

TABLE X5.2 ILSAC GF-6B Passenger Car Engine Oil Standard

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 °C to temperature at which 40 000 cP is attained or –40 °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_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	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 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 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 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	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.
Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to 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.
OR	
Aged oil low temperature viscosity	ASTM Sequence IIIHA (ASTM D8111)
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	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.
Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to 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, 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)
Homogeneity and miscibility	ASTM D6922
	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 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

Requirement		Criterion		
	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

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.

Engine Test Requirements[A]	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20,	All Others[B]
	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, µm	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, cyl #8, avg, µm	Rate & report[D]	Rate & report[D]
Ring gap increase, cyl #1 and #8, avg, µm	Rate & report[D]	Rate & report[D]
OR		
ASTM D8256 (Sequence VH)		
Average engine sludge, merits	7.4	7.4
Average rocker cover sludge, merits	7.4	7.4
Average engine varnish, merits	8.6	8.6
Average piston skirt varnish, merits	7.6	7.6
Oil screen clogging, % area	Rate & report	Rate & report
Hot stuck compression rings	None	None
ASTM D6709 (Sequence VIII)		
Bearing weight loss, mg	26 (max)	26 (max)
Bench Test and Measured Parameter[A]	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20,	All Others[B]
	SAE 0W-30, SAE 5W-30,	
	SAE 10W-30	
ASTM D6557 (Ball Rust Test), 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_20	50	50
with 1.0 % H_20	50	50
with 2.0 % H_20	50	50
with 3.0 % H_20	50	50
ASTM D4951, phosphorus percent mass, max[F]	0.08[G]	NR
ASTM D4951, phosphorus percent mass, min[F]	0.06[G]	0.06[G]
ASTM D4951 or D2622, sulfur percent mass, max[F]		
SAE 0W-20, 0W-30, 5W-20, and 5W-30	0.5[G]	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[I]	100/0	100/0
ASTM D6922, homogeneity and miscibility	[J]	[J]
ASTM D6709, (Sequence VIII) shear stability	[K]	[K]
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.

[I] 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 mm^2/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[A]			
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 D7589, (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)[B]			
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)[D]	5 (max)[D]	5 (max)[D]
Bench Test and Measured Parameter[A]			
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 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 a) or b) above.		
OR			
ASTM D7528, (ROBO Test), aged oil low temperature viscosity[E]	d) 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 the MRV temperature specified in SAE J300 for original viscosity grade.		
	e) 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).		
	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 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[B]	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_2O	50	50	50
with 1.0 % H_2O	50	50	50
with 2.0 % H_2O	50	50	50
with 3.0 % H_2O	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[G]	NR	0.5[G]
SAE 10W-30	0.6[G]	NR	0.6[G]
All other viscosity grades	NR	NR	0.6[G]
ASTM D892 (Option A), foaming tendency			
Sequence I, mL, max, tendency/stability	10/0[I]	10/0[J]	10/0[I]
Sequence II, mL, max, tendency/stability	50/0[I]	50/0[J]	50/0[I]
Sequence III, mL, max, tendency/stability	10/0[I]	10/0[J]	10/0[I]
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability[I]	100/0	100/0	100/0
ASTM D6922, homogeneity and miscibility	[K]	[K]	[K]
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 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 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.

[I] 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)

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

Performance Test	Performance Criteria	
Sequence VID (ASTM D7589)[A]		
Viscosity Grade	FEI SUM	FEI 2 minimum after 100 hours aging
XW-16[B]	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)[A]		
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[B]	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	

[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, max		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				
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
ASTM 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 viscosity[D]		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.		
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 IIIHA or ROBO		b) If CCS viscosity measured is higher than 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 next higher viscosity grade).		
Measure CCS viscosity of EOT IIIHA sample at CCS temperature corresponding to original viscosity grade		c) EOT Seq. IIIHA 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 a) or b) above.		
OR				
ASTM D7528, (ROBO Test), aged oil low-temperature viscosity[D]		d) 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.		
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 IIIHA or ROBO		e) 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).		
Measure CCS viscosity of ROBO sample at CCS temperature 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[B]		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_2O		50	50	50
with 1.0 % H_2O		50	50	50
with 2.0 % H_2O		50	50	50
with 3.0 % H_2O		50	50	50
ASTM D4951 or D5185, phosphorus % mass, max[F]		0.08[G]	NR	0.08[G]
ASTM D4951 or D5185, phosphorus % mass, min[F]		0.06[G]	0.06[G]	0.06[G]
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[I]	10/0[H]
Sequence II, mL, max, tendency/stability		50/0[H]	50/0[I]	50/0[H]
Sequence III, mL, max, tendency/stability		10/0[H]	10/0[I]	10/0[H]
D6082 (Option A), high-temperature foaming mL, max, tendency/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		Stay in grade[K]	Stay in grade[K]	Stay in grade[K]
ASTM D6278, (Diesel Injector) shear stability, KV @ 100 °C after 30 passes, min				
SAE XW-16		5.8	5.8	5.8
All other viscosity grades		NR	NR	NR
ASTM D5133, gelation index, max[B]		12[L]	NR	12[L]
ASTM D6335, TEOST 33C, high-temperature deposits, total deposit 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.

[I] 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.

X8.2 Resource Conserving in Conjunction with API Service Category SP (See Table X8.2)

TABLE X8.2 Resource Conserving Primary Performance Criteria with API Service Category SP

Performance Test	Performance Criteria	
	FEI SUM	FEI 2 minimum after 125 hours aging
Sequence VIE (ASTM D8114)[A]		
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	

[A] Viscosity grades are limited to 0W, 5W, and 10W multigrade oils.