Doc: PCD 25 (26822) WC
October 2024

BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

मोटर वाहन अनुप्रयोग (डीजल और गैसोलीन) के लिए आंतरिक दहन इजन क्रैंककेस तेल) — विशिष्टि

(IS 13656 *का चौथा पुनरीक्षण*)

Draft Indian Standard

INTERNAL COMBUSTION ENGINE CRANKCASE OILS FOR AUTOMOTIVE APPLICATION (DIESEL AND GASOLINE) — SPECIFICATION

(*Fourth Revision of* IS 13656)

(ICS No. 75.100)

Lubricants and their related products Sectional Committee, PCD 25	Last date for receipt of comment is **22 December 2024**

FOREWORD

(*Formal clauses will be added later*)

IS 496 'Specification for Automotive Internal Combustion Engine Lubricating Oils,' was first published in 1955 to incorporate the changing requirements of OEMs and users. The 1982 version was base stock specific. There were two other standards on the subject, based on re-refined oils and base-stock of mixed crude as:

a) IS 9048 : 1982 Specification for Re-refined Automotive Internal Combustion Engine Lubricating Oils (*first revision*), and

b) IS 10356 : 1982 Specification for Automotive Internal Combustion Engine Lubricating Oils from Base Stocks of Mixed Crude.

The Committee decided to combine the requirements in all the above standards and IS 13656 : 1993 for Internal Combustion Engine Crankcase Oils (Gasoline and Diesel) covering the requirements of upgraded quality of crankcase oil irrespective of varying base stock was published.

It was first revised in 2002 to reflect some of the performance standards that were being employed by the API, ACEA and OEMs to define oils that were required for equipment in use in the country. Two types of diesel lubricating oils, namely, EDL5 and EDL6 were included with their equivalent international performance levels. EPL category of passenger car motor oils were drafted in and a new type EPL4 with overseas performance as API SJ level was

included. Besides, the corresponding equivalent overseas performance levels were well defined. The standards were covering two principal application-areas of lubricants with those categories that were recommended by automotive OEMs for their engines with respect to a) Diesel Engine Oils, and b) Passenger Car Motor Oils.

Considering various factors such as frequent upgradation of global specifications, obsolescence of hardware, increasing costs of engine testing and the dearth of test facilities, it was anticipated that oil marketers would increasingly utilize existing engine-test database to claim performance against various categories. Where the product performance category essentially involved a cross labelling between an API category, an ACEA category and/or an OEM specification, the particular code of practice and/or read across guide-lines stipulated by the particular agency needed to be utilized in order to support the particular claim.

In the second revision published in 2014, the categories EDL1 and EPL1 were excluded. The international equivalents for EDL2 and EDL3 were upgraded to API CF. Two new categories, i.e., EDL6 equivalent to API CG-4+MB 228.3 and EDL7 equivalent to API CH-4+MB 228.3 performance level were included. Besides, the references to ASTM Standards had been updated.

In the third revision published in 2019, EDL8, EDL9, EDL10, EDL11 and EDL12 for diesel engine oil and EPL5, EPL6, EPL7 and EPL8 categories for gasoline engine oil were included in view of the latest developments in engine oil specification catering the needs of BS IV and BS VI compliant engines. The Committee also decided to remove the qualification approval from the standard as it was not relevant.

In this fourth revision, along with editorial and typographic corrections, the following major changes have been made:

a) Diesel engine oil performance category EDL2 and gasoline engine oil performance category EPL2 have been excluded;

b) Gasoline engine oil performance category EPL9 has been included; and

c) Qualification Approval (QA) procedure for defence products has been included so as to take care of supplies to defence forces.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

1.1 This standard prescribes the requirements and methods of sampling and test for the various types (*see* **3**) of internal combustion engine lubricating oils for use in diesel engines and gasoline engines used in passenger and commercial vehicles including off-highway equipment.

1.2 This standard permits the use of multi-grade engine oils for the lubrication of spark/ compression-ignition types of internal-combustion engines used in passenger and commercial vehicles, off-highway vehicles and industrial equipment.

1.3 Lubricating oils, covered in this standard, are broadly classified into two types as specified in **3**.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards listed in Annex A.

3 CLASSIFICATIONS

3.1 Types and Performance Level Categories

Internal combustion engine lubricating oils covered in this standard are of two types:

a) Diesel engine oils; and
b) Petrol engine oils.

They shall be qualified under the different performance-level categories, as per designations indicated in **3.1.1** and **3.1.2**. Corresponding international equivalent performance levels and the prescribed engine tests are indicated, for the purpose of ready reference, against each of the designated categories.

3.1.1 *Diesel Engine Oils* (*DEO*)

Sl No.	IS Category	International Equivalent	Engine Tests (For test methods, see Tables 2-8)
(1)	(2)	(3)	(4)
i)	EDL 3	API CF Plus Mack T-7/T-8A	CRC L-38 or Sequence VIII, Caterpillar 1M-PC T-7 or Mack T-8A
ii)	EDL 4	API CF-4	CRC L-38 or Sequence VIII, Mack T-6 or Mack T-9 or Mack T-10, Mack T-7 or Mack T-8A, Caterpillar 1K[1], Corrosion Bench Test (CBT)[1]
iii)	EDL 5	API CF-4 combined with (ACEA E2-96 / MB 228.1[2])	CRC L-38 or Sequence VIII, Mack T-6 or Mack T-9 or T-10, Mack T-7 or Mack T-8A, Caterpillar1K[1], Corrosion Bench Test (CBT)[1], OM 364A or OM 441LA, OM602A

iv)	EDL 6	API CG-4 combined with (ACEA E3-96 / MB 228.3[2])	CRC L-38 or Sequence VIII, Mack T-8, Sequence IIIF or IIIG, Caterpillar 1N, Corrosion Bench Test (CBT), Roller Follower Wear Test (RFWT), EOAT, OM 364A or OM 441LA or OM 501LA, OM602A or OM 646LA
vi)	EDL 7	API CH-4 combined with MB 228.3[2]	Caterpillar 1P, Caterpillar 1K, Mack T-9 or T-10 or T-12, Roller Follower Wear Test (RFWT), Cummins M11 or ISM, Mack T8E, Sequence IIIF or IIIG, High Temperature Corrosion Bench Test (HTCBT), EOAT, OM 364A or OM 441LA or OM 501LA, OM602A or OM 646LA
vii)	EDL8	API CI-4	Caterpillar 1P or Caterpillar 1R, Caterpillar 1K, Mack T-10 or Mack T-12, Cummins M11 EGR or Cummins ISM, Mack T-8E, Roller Follower Wear Test (RFWT), Sequence IIIF or IIIG, EOAT
viii)	EDL9	API CI-4 PLUS	All engine tests of EDL8 + Mack T-11 engine test
ix)	EDL10	API CJ-4	Mack T-12, Cummins ISM, Caterpillar C13, Mack T-11, Cummins ISB, Caterpillar 1N, Sequence IIIF or IIIG or IIIH, EOAT, Roller Follower Wear Test (RFWT)
x)	EDL11	API CK-4	Mack T-12, Mack T-13, Cummins ISM, Caterpillar C13, Mack T-11, Cummins ISB, Roller Follower Wear Test (RFWT), Caterpillar 1N, COAT
xi)	EDL12	API FA-4	To pass all engine tests of EDL11 and refer Table 8.2

NOTES

1) CF-4 category lists Cummins NTC-400 (ASTM D5290) as test method required for this category. Due to lack of critical test parts, the NTC-400 test is no longer available as a calibrated test, and has been replaced in this category by the requirement of a second caterpillar 1K test and corrosion bench test (CBT). Alternatively, instead of running second Caterpillar 1K test and CBT, data from NTC-400 tests, run in calibrated test stands, can be used to support this category.
2) In case of MB claims, the package approval letter from MB is to be considered.
3) For bench test requirement refer respective performance level bench test table.
4) The higher performance grades which are backward compatible with the lower performance grades, the data of such higher performance grades may be considered for the approval/qualification of lower performance grades.
5) 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.

3.1.2 *Petrol Engine Oils*

Sl. No	IS Category	International Equivalent	Engine Tests (For test methods, *see* 3.4)
(1)	(2)	(3)	(4)
i)	EPL 3	API SG	CRC L-38 or Sequence VIII, Sequence IID, Sequence IIIE, Sequence VE
ii)	EPL 4	API SJ	CRC L-38 or Sequence VIII, Sequence IID or BRT, Sequence IIIE or Sequence IIIF or Sequence IIIG, Sequence VE or (Sequence IVA + Sequence VG)
iii)	EPL 5	API SL	Sequence IIIF or IIIG, Sequence IVA, Sequence VG, Sequence VIII
iv)	EPL 6	API SM	Sequence IIIG, Sequence IIIGA or ROBO, Sequence IVA, Sequence VG, Sequence VIII
v)	EPL 7	API SN	Sequence IIIG or Sequence IIIH, Sequence IVA, Sequence VG or Sequence VH, Sequence VIII
		API SN with Resource Conserving	All API SN tests, Sequence VID or Sequence VIE, Sequence VIF
vi)	EPL 8	API SN PLUS	Sequence IX test in addition to API SN engine tests
		API SN PLUS with Resource Conserving	All API SN PLUS tests, Sequence VID or Sequence VIE, Sequence VIF
vii)	EPL 9	API SP	Sequence IIIH, Sequence IVB, Sequence VH, Sequence VIII, Sequence IX, Sequence X
		API SP with Resource Conserving	All API SP tests, Sequence VIE, Sequence VIF

NOTES
1) Latest version of all international specifications referred to in this specification to be followed.
2) For bench test requirement refer respective bench test table.
3) API SN with SN PLUS and "Resource Conserving" and API SN with SN PLUS are also backward compatible to API Service Categories before API SN.

3.2 The oils may be labelled as fuel-efficient by suffixing the grade name with word 'FE', provided the oil meets fuel-economy targets as per the International Lubricant Standardization and Approval Committee (ILSAC) Standards of Passenger car engine oil.

3.3 Viscosity Grades

3.3.1 The oils shall conform to one of the SAE mono-viscosity grades or SAE multi-grades (*see* Table 1), which are combinations of W-Grades and other mono-grades, as for example: SAE 10W and SAE 30 for the SAE 10W-30 grade. Viscosity limits for each of the mono-grades are also given in Table 1.

3.3.2 In case of multi-grades, the prescribed viscosity limits (*see* Table 1) for both the constituent components of the multi-grade, shall be met.

3.4 Engine -Performance Test Requirements

The approved engine tests for performance evaluation of the two types of lubricants and their various performance categories have been listed in the Tables as given below, together with the prescribed requirements:

a) Diesel engine oils (*see* Table 2 to Table 8); and
b) Passenger car motor oils (*see* Table 9 to Table 13).

It is possible that the performance test data would be generated on engine tests carried out in different laboratories conducted at different period of time, using base stocks from different sources. Hence provisions available for Base Oil Interchange (BOI), Viscosity Grade Read-Across (VGRA), Viscosity Modifier Interchange (VMI), minor additive component substitution as provided in the relevant API/ACEA/OEM specification to be considered.

NOTE: Multiple Test Acceptance Criteria (MTAC) should be used for any data-based approach for evaluation of the quality and performance of a formulation where more than one test may be run. Generally, for a candidate tested once, test data for each criterion shall be a pass. For a candidate tested twice, the mean (average) value of each result shall be a pass. For a candidate tested three or more times, one test might be declared an outlier and thus discarded and the mean (average) value of retained test data for each result shall be a pass. MTAC shall be applicable to the specific tests carried out as detailed in Table 5.1, Table 6.1 and Table 7.1.

4 REQUIREMENTS

4.1 General

The oils shall be formulated by blending lube base stocks comprising of virgin oil or re-refined oil or synthetic fluid, or a combination of any of these, and additive components as necessary, to meet the requirements of this standard.

4.2 Physico-Chemical Requirements

4.2.1 The oil shall be free from suspended matter, grit, water or any other foreign matter and impurities.

4.2.2 The oil shall comply with the physico-chemical and other bench-test requirements as given below:

a) *For diesel engine oils*:
   i) Viscosity requirements as per Table1; and
   ii) Physico-chemical requirements (other than viscosity) as per Table 14.
b) *For passenger car motor oils:*
   i) Viscosity requirements as per Table 1; and
   ii) Physico-chemical requirements (other than viscosity) as per Table 14.

4.3 Stability of Finished Lubricating Oils

The finished blended oils shall have the additive elements uniformly distributed throughout the oil and shall show no evidence of instability at temperature specified in the homogeneity test described in Annex B.

5 PRODUCT QUALITIFICATION (FOR DEFENSE REQUIRMENTS ONLY)

The oil shall be qualified for use in defence forces in accordance with the provision of this standard and as per the details provided in Annex C. The authority for recommending a Qualification Approval is CQA(PP), Kanpur.

6 PACKING AND MARKING

6.1 Packing

The material shall be packed in metal containers or in any other suitable containers as agreed to between the purchaser and the supplier.

6.2 Marking

6.2.1 The container shall be securely closed and marked with the following:

a) Indication of the source of manufacture, recognized trade-mark, if any;
b) Type and viscosity grade;
c) Net mass/volume of the material;
d) Identification in code or otherwise to enable the lot of consignment of manufacture to be traced back from records; and
e) Any other statutory requirement.

6.2.2 All markings including batch number or lot of manufacture shall be made on one flat end when the material is packed in barrels.

6.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

7 SAMPLING

7.1 Representative samples of the material shall be drawn as prescribed in IS 1447 (Part 1).

7.2 Number of Tests

Test for all the characteristics given in Table 1 and Table 14 of this standard shall be conducted on composite samples.

7.3 Criteria for Conformity

The lot shall be declared as conforming to the requirements of the specification, if all the results on the composite sample satisfy the relevant requirements.

Table 1 Engine Oil Viscosity Classification (*see* Note 1)
(*Clauses* 3.3.1, 3.3.2, 4.2.2 (a) (i) *and* 4.2.2 (b) (i))

Sl. No	SAE Viscosity grade	Low Temp Cranking Viscosity, mPa-s, *Max*	Low Temp Pumping Viscosity, mPa-s, *Max* (*see* Note 2)	Low-Shear-Rate, Kinematic Viscosity, mm^2/s at 100 °C, *Min*	Low-Shear-Rate, Kinematic Viscosity, mm^2/s at 100 °C, *Max*	High-Shear-Rate Kinematic Viscosity(mPa-s), at 150 °C and 10^6 s^{-1}, *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Method of Test					
		ASTM D5293	ASTM D4684	IS 1448 (Part 25/Sec 1)	IS 1448 (Part 25/Sec 1) / ASTM D4683 / CEC L-36-A-90 (ASTM D4711) / ASTM D5481	
i)	0 W	6200 at – 35 °C	60000 at – 40 °C	3.8	—	—
ii)	5 W	6600 at – 30 °C	60000 at – 35 °C	3.8	—	—
iii)	10 W	7000 at – 25 °C	60000 at – 30 °C	4.1	—	—
iv)	15 W	7000 at – 20 °C	60000 at – 25 °C	5.6	—	—
v)	20 W	9500 at – 15 °C	60000 at – 20 °C	5.6	—	—
vi)	25 W	13000 at – 10 °C	60000 at – 15 °C	9.3	—	—
vii)	8			4.0	<6.1	1.7
viii)	12			5.0	<7.1	2.0
ix)	16			6.1	<8.2	2.3
x)	20	—	—	6.9	<9.3	2.6
xi)	30	—	—	9.3	<12.5	2.9
xii)	40	—	—	12.5	<16.3	3.5 (0W-40, 5W-40 and 10W-40 grades)
xiii)	40	—	—	12.5	<16.3	3.7 (15W-40, 20W-40, 25W-40, and 40 grades)
xiv)	50	—	—	16.3	<21.9	3.7
xv)	60	—	—	21.9	<26.1	3.7

NOTES
1) SAE J300, April 2021
2) ASTM D4864: The presence of any yield stress detectable by this method constitutes a failure regardless of viscosity.

Table 2 Engine Test Sequence for Diesel Engine Oils for EDL3
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	Characteristics	Requirements	Method of Test
		EDL 3	

(1)	(2)	(3)			(4)
CRC L-38	Bearing weight loss, mg, *Max*	50			ASTM D5119
OR					
Sequence VIII	Bearing weight loss, mg, *Max*	1 test	2 test	3 test	ASTM D6709
		29.3	31.9	33.0	
Caterpillar 1M-PC	a) Top ring groove filling, percent volume, *Max*	70			ASTM D6618
	b) Weighted total demerit, *Max*	240			
	c) Piston ring sticking	none			
	d) Piston, ring and liner scuffing	none			
Mack T-7	Average rate of kinematic viscosity increase during last 50 h, (mm^2/s at 100 °C)/h, *Max*	0.040			ASTM Research Report RR:DO2:1220
OR					
Mack T-8A	Average rate of kinematic viscosity increase from 100 h to 150 h, (mm^2/s at 100 °C)/h, *Max*	0.20			ASTM D5967

NOTE – EDL3 is applicable for defence applications only.

Table 3 Engine Test Sequence for Diesel Engine Oils for EDL4 and EDL5
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	**Characteristics**	**Requirements**		**Method of Test**
		EDL 4	EDL 5	
(1)	**(2)**	**(3)**	**(4)**	**(5)**
CRC L-38	Bearing weight loss, mg, *Max*	50	50	ASTM D5119
OR				
Sequence VIII	Bearing weight loss, mg, *Max*	33	33	ASTM D6709
Mack T-6	Merit rating, *Min*	90	90	
OR				

Mack T-9	a) Top piston ring weight loss, Average, mg, *Max*	150			150			ASTM D6483
	b) Liner wear, µm, *Max*	40			40			
OR								
Mack T-10	Top pistion ring weight loss, mg, *Max*	180			180			ASTM D6987 / ASTM D6987M
	Liner wear, µm, *Max*	47			47			
Mack T-7	Average rate of kinematic viscosity increase during last 50 h, (mm^2/s at 100 °C)/h, *Max*	0.040			0.040			ASTM Research Report RR:DO2:1220
OR								
Mack T-8A	Average rate of kinematic viscosity increase during last 150 h, (mm^2/s at 100 °C)/h, *Max*	0.20			0.20			ASTM D5967
Caterpillar 1K	Run Number	2 test	3 test	4 test	2 test	3 test	4 test	ASTM D6750
	a) Weighted demerits (WDK), *Max*	332	339	342	332	339	342	
	b) Top groove fill (TGF), percent, *Max*	24	26	27	24	26	27	
	c) Top land heavy carbon (TLHC), percent, *Max*	4	4	5	4	4	5	
	d) Average oil consumption g/MJ, (0-252 h), *Max* (g/kW-h) (0-252 h), *Max*	0.14 (0.5)	0.14 (0.5)	0.14 (0.5)	0.14 (0.5)	0.14 (0.5)	0.14 (0.5)	
	e) Final oil consumption, g/MJ, (228-252 h), *Max* (g/Kw-h), (228-252 h), *Max*	0.75 (0.27)	0.75 (0.27)	0.75 (0.27)	0.75 (0.27)	0.75 (0.27)	0.75 (0.27)	

	f) Piston ring and liner scuffing Number of tests allowed	None	None	None	None	None	None	
	g) Piston ring sticking	None	None	None	None	None	None	
Corrosion Bench Test (CBT)	a) Copper, mg/kg (ppm) increase, *Max*	—	20	—	—	20		ASTM D5968
	b) Lead, mg/kg (ppm) increase, *Max*	—	60	—	—	60		
	c) Tin, mg/kg (ppm), *Max*	—	To Report	—	—	To Report		
	d) Copper strip rating, *Max*	—	3	—	—	3		IS 1448 (Part15) / ASTM D130
OM 364A	a) Bore polishing, percent, *Max*	—	—	—	—	8		CEC-L-42-A-92
	b) Piston cleanliness, merit, *Min*	—	—	—	—	31	—	
	c) Average cylinder wear, µm, *Max*	—	—	—	—	7	—	
	d) Average engine sludge, merit, *Min*	—	—	—	—	9	—	
	e) Oil consumption, kg/test, *Max*	—	—	—	—	18	—	
OR								
OM 441 LA	a) Bore polishing, percent, *Max*	—	—	—	—	2.0	—	CEC-L-52-T-97
	b) Piston cleanliness, merit, *Min*	—	—	—	—	25	—	
	c) Average cylinder wear, µm, *Max*	—	—	—	—	8	—	
	d) Average engine sludge, merit, *Min*	—	—	—	—	9	—	
	e) Engine deposit, demerits, *Max*	—	—	—	—	3	—	
	f) Wear rating, demerits, *Max*	—		—	—	2.5	—	

	g) Ring sticking, ASF, *Max*	—		—	—	1	—	
	h) Oil consumption, kg/test, *Max*	—		—	—	100	—	
	i) Boost pressure loss, 400 h, percent	—		—	—	Report	—	
OM 602A	a) Bore polishing, percent, *Max*	—	—	—	—	6	—	CEC-L-42-A-95
	b) Piston cleanliness, merit, *Min*	—	—	—	—	22	—	
	c) Average cylinder wear, µm, *Max*	—	—	—	—	18	—	
	d) Average engine sludge, merit, *Min*	—	—	—	—	8.9	—	
	e) Oil consumption, kg/test, *Max*	—	—	—	—	10	—	
	f) Average cam wear, µm, *Max*	—	—	—	—	50	—	
	g) Viscosity increase at 40 ºC, percent, *Max*	—	—	—	—	80	—	

Table 4 Engine Test Sequence for Diesel Engine Oils for EDL6
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	**Characteristics**	**Requirements**			**Method of Test**
		EDL 6			
(1)	**(2)**	**(3)**			**(4)**
CRC L-38	a) Bearing weight loss, mg, *Max*	50			ASTM D5119
OR					
Sequence VIII	a) Bearing weight loss, mg, *Max*	1 test	2 test	3 test	ASTM D6709
		29.3	31.9	33.0	
	b) Used oil viscosity, mm^2/s, greater than SAE J300 lower limit for grade, *Min*	0.5	0.5	0.5	
Mack T-8	a) Viscosity increase at 3.8 percent soot, mm^2/s, *Max*	1 test	2 test	3 test	ASTM D5967
		11.5	12.5	13.0	
	b) Filter plugging, differential pressure, kPa(psi), *Max*	138(20)	138(20)	138(20)	

	c) Oil consumption, g/kW-h (lb/bhp-h), *Max*	0.304 (0.000 5)	0.304 (0.000 5)	0.304 (0.000 5)	
Sequence III F	60 h viscosity (at 40 °C) increase from 10 min sample percent, *Max*	325	349	360	ASTM Research Report RR:DO2:149
OR					
Sequence III G	Kinemic viscosity, percent increase at 40 °C, *Max*	150	173	184	ASTM D7320
Caterpillar 1N	Run Number	xx	xx	xx	ASTM D6750
	a) Weighted demerits (WDN), *Max*	286.2	311.7	323.0	
	b) Top groove fill (TGF), percent, *Max*	20	23	25	
	c) Top land heavy carbon (TLHC), percent, *Max*	3	4	5	
	d) Oil consumption g/kW-h (0-252 h), *Max*	0.5	0.5	0.5	
	e) Piston ring and liner scuffing, number of tests allowed	none	none	none	
	f) Piston ring sticking	none	none	none	
RFWT	Roller follower wear, µm, *Max*	11.4	12.4	12.7	ASTM D5966
EOAT	Aeration, volume percent, *Max*	10.0	—	—	ASTM D6894
Corrosion Bench Test (CBT)	a) Copper, mg/kg (ppm) increase, *Max*	—	20	—	ASTM D5968
	b) Lead, mg/kg (ppm) increase, *Max*	—	60	—	
	c) Tin, mg/kg (ppm), *Max*	—	To Report	—	
	d) Copper strip rating, *Max*.	—	3	—	IS 1448 (Part15) / ASTM D130
OM 364A	a) Bore polishing, percent, *Max*	—	2.5	—	CEC-L-42-A-92
	b) Piston cleanliness, merit, *Min*	—	35	—	
	c) Average cylinder wear, µm, *Max*	—	6	—	
	d) Average engine sludge, merit, *Min*	—	9.5	—	
	e) Oil consumption, kg/test, *Max*	—	12	—	
OR					

OM 441LA	a) Bore polishing, percent, *Max*	—	2.0	—	CEC-L-52-T-97
	b) Piston cleanliness, merit, *Min*	—	25	—	
	c) Average cylinder wear, µm, *Max*	—	8	—	
	d) Average engine sludge, merit, *Min*	—	9	—	
	e) Engine deposit, demerits, *Max*	—	3	—	
	f) Wear rating, demerits, *Max*	—	2.5	—	
	g) Ring sticking, ASF, *Max*	—	1	—	
	h) Oil consumption, kg/test, *Max*	—	100	—	
	j) Boost pressure loss, 400 h, percent, *Max*	—	4.0	—	
OR					
OM 501 LA	a) Piston cleanliness, merit, *Min*	—	19	—	CEC SG-L-101
	b) Engine sludge, average merit, *Min*	—	9	—	
	c) General engine deposit, demerits, *Max*	—	2	—	
	d) Ring sticking, ASF, *Max*	—	1	—	
	e) Bore polishing percent, *Max*	—	2	—	
	f) Cylic wear, average µm,	—	8	—	
	g) Wear rating, demerits, *Max*	—	2	—	
	h) Turbocharger deposit	—	2	—	
	i) Specific oil consumption, g/h, *Max*	—	30	—	
OM 602A	a) Bore polishing, percent, *Max*	—	4.5	—	CEC-L-42-A-95
	b) Piston cleanliness, merit, *Min*	—	24	—	
	c) Average cylinder wear, µm, *Max*	—	15	—	
	d) Average engine sludge, merit, *Min*	—	8.9	—	
	e) Oil consumption, kg/test, *Max*	—	10	—	
	f) Average cam wear, µm, *Max*	—	45	—	
	g)Viscosity increase at 40 °C, percent, *Max*	—	70	—	
OR					
OM 646 LA	a) Engine sludge, merit, *Min*	—	8.7	—	CEC SG-L-099
	b) Piston cleanliness, merit,	—	12	—	
	c) Piston ring wear axial @ ring 1, µm, *Max*	—	10.4	—	

	d) Piston ring wear axial @ ring 2, µm, *Max*	—	6	—	
	e) Piston ring wear axial @ ring 3, µm, *Max*	—	5	—	
	f) Piston ring wear radial @ ring 1, µm, *Max*	—	10	—	
	g) Piston ring wear radial @ ring 2, µm, *Max*	—	12	—	
	h) Piston ring wear radial @ ring 3, µm, *Max*	—	8	—	
	j) Main bearing wear, average, µm, *Max*	—	2.1	—	
	k) Con rod bearing, average, µm, *Max*	—	2.1	—	
	m) Cam wear inlet, average, µm, *Max*	—	110	—	
	n) Cam wear outlet, average, µm, *Max*	—	140	—	
	p) Cylinder wear, average, µm, *Max*	—	5	—	
	q) Bore polishing, percent, *Max*	—	3.5	—	
	r) Timing chain wear, percent *Max*	—	0.4	—	
	s) Viscosity Increase at 100 °C, percent, *Max*	—	100	—	
	t) Ring sticking	—	No	—	
	u) Tapet wear inlet, average, µm	—	Rate and report	—	
	v) Tapet wear outlet, average, µm	—	Rate and report	—	
	w) Oil consumption, g/test, *Max*	—	7000	—	

Table 5.1 Engine Test Sequence for Diesel Engine Oils for EDL7
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	**Characteristics**	**Requirements**			**Method of Test**
		EDL 7			
(1)	**(2)**	**(3)**			**(4)**
		1 test	2 test	3 test	
Caterpillar IP	a) Weighted demerits (WDP), *Max*	350	378	390	ASTM D6681
	b) Top Groove Carbon (TGC), demerits, *Max*	36	39	41	

	c) Top land carbon (TLC) percent, demerits, *Max*	40	46	49	
	d) Average oil consumption, g/h (0-360 h), *Max*	12.4	12.4	12.4	
	e) Final oil consumption, g/h (312-360 h), *Max*	14.6	14.6	14.6	
	f) Piston, ring and liner scuffing	None	None	None	
Cat 1K	a) Weighted demerits (WDK), *Max*	332	347	353	ASTM D6750
	b) Top groove fill (TGF), percent, *Max*	24	27	29	
	c) Top land heavy carbon (TLHC), percent, *Max*	4	5	5	
	d) Average oil consumption,				
	g/kW-h (0 h -252 h), *Max*	0.54	0.54	0.54	
	g/MJ (0 h -252 h), *Max*	0.15	0.15	0.15	
	e) Piston, ring and liner scuffing	None	None	None	
Mack T9	a) Average liner wear, normalized to 1.75 percent soot, µm, *Max*	25.4	26.6	27.1	ASTM D6483
	b) Average top ring weight loss, mg, *Max*	120	136	144	
	c) EOT used oil lead content – less new oil lead content, mg/kg (ppm), *Max*	25	32	36	
OR					
Mack T 10	a) Ring wear, mg, *Max*	150	159	163	ASTM D6987
	b) Liner wear, *µm, Max*	32	34	35	
	c) Lead content at EOT, mg/kg, *Max*	50	56	59	
OR					
Mack T 12	a) Top ring weight loss, mg, *Max*	120	132	137	ASTM D7422
	b) Liner wear, *µm, Max*	30	30.8	31.1	
	c) Lead content at EOT, mg/kg, *Max*	65	75	79	
RFWT	Average pin wear, µm, *Max* (mils, *Max.*)	7.6 (0.30)	8.4 (0.33)	9.1 (0.36)	ASTM D5966
EOAT	Aeration, volume percent, *Max*	8.0	8.0	8.0	ASTM D6894
Cummins M11	a) Rocker pad average weight loss, normalized to 4.5 percent soot, mg, *Max*	6.5	7.5	8.0	ASTM D6838
	b) Oil filter differential pressure at EOT, kPa, *Max*	79	93	100	
	c) Average engine sludge, CRC merits at EOT, *Min*	8.7	8.6	8.5	
OR					
ISM	a) Cross head wear, mg, *Max*	7.5	7.8	7.9	ASTM D7468
	b) Oil filter delta pressure at 150 h, kPa, *Max*	79	95	103	
	c) Sludge rating, CRC merits, *Min*	8.1	8	8	

Ext. Mack T8E	a) Relative viscosity at 4.8 percent soot by TGA, mm^2/s, *Max*	2.1	2.2	2.3	ASTM D5967
	b) Viscosity increase at 3.8 percent soot by TGA, mm^2/s, *Max*	11.5	12.5	13.0	
Sequence IIIF	60 h viscosity at 40 °C, increase from 10 min sample, percent, *Max*	295	295#	295#	ASTM D6984
OR					
Sequence IIIG	Kinemic viscosity percent increase at 40 °C, *Max*	150	150#	150# (FF)	ASTM D7320
OR					
Sequence IIIH	60 h kinemic viscosity percent increase at 40 °C, *Max*	249	249#	249#	ASTM D8111
HTC BT	Used oil elemental concentration: (135 °C)				ASTM D6594
	a) Copper, mg/kg (ppm) increase, *Max*	—	20	—	
	b) Lead, mg/kg (ppm) increase, *Max*	—	120	—	
	c) Tin, mg/kg (ppm) increase	—	To Report	—	
	d) Copper Strip rating, *Max*	—	3	—	
OM 364A	a) Bore polishing, percent, *Max*	—	2.5	—	CEC-L-42-A-92
	b) Piston cleanliness, merit, *Min*	—	35	—	
	c) Average cylinder wear, µm, *Max*	—	6	—	
	d) Average engine sludge, merit, *Min*	—	9.5	—	
	e) Oil consumption, kg/test, *Max*	—	12	—	
OR					
OM 441 LA	a) Bore polishing, percent, *Max*	—	2.5	—	CEC-L-52-T-97
	b) Piston cleanliness, merit, *Min*	—	25	—	
	c) Average cylinder wear, µm, *Max*	—	8	—	
	d) Average engine sludge, merit, *Min*	—	9	—	
	e) Engine deposit, demerits, *Max*	—	3	—	
	f) Wear rating, demerits, *Max*	—	2.5	—	
	g) Ring sticking, ASF, *Max*	—	1	—	
	h) Oil consumption, kg/test, *Max*	—	100	—	
	j) Boost pressure loss, 400 h, percent, *Max*	—	4.0	—	
OR					
OM 501 LA	a) Piston cleanliness, merit, *Min*	—	20	—	CEC SG-L-101
	b) Engine sludge, average merit, *Min*	—	9	—	
	c) General engine deposit, demerits, *Max*	—	2	—	
	d) Ring sticking, ASF, *Max*	—	1	—	
	e) Bore polishing percent, *Max*	—	2	—	
	f) Cyclic wear, average µm, *Max*	—	8	—	
	g) Wear rating, demerits, *Max*	—	3	—	

	h) Turbocharger deposit, demerits, *Max*	—	2	—	
	j) Specific oil consumption, g/h, *Max*	—	30	—	
OM 602A	a) Bore polishing, percent, *Max*	—	4.5	—	CEC-L-42-A-95
	b) Piston cleanliness, merit, *Min*	—	24	—	
	c) Average cylinder wear, new[#]/old, µm, *Max*	—	15[#]/10	—	
	d) Average engine sludge, merit, *Min*	—	8.9	—	
	e) Oil consumption, kg/test, *Max*	—	10	—	
	f) Average cam wear, new[#]/old, µm, *Max*	—	45[#]/28	—	
	g) Viscosity increase at 40 ºC, percent, *Max*	—	70	—	
OR					
OM 646 LA	a) Engine sludge, merit, *Min*	—	8.8	—	CEC SG-L-099
	b) Piston cleanliness, merit, *Min*	—	14	—	
	c) Piston ring wear axial @ ring 1, µm, *Max*	—	10.4	—	
	d) Piston ring wear axial @ ring 2, µm, *Max*	—	6	—	
	e) Piston ring wear axial @ ring 3, µm, *Max*	—	5	—	
	f) Piston ring wear radial @ ring 1, µm, *Max*	—	10	—	
	g) Piston ring wear radial @ ring 2, µm, *Max*	—	12	—	
	h) Piston ring wear radial @ ring 3, µm, *Max*	—	8	—	
	j) Main bearing wear, average, µm, *Max*	—	2.1	—	
	k) Con rod bearing, average, µm, *Max*	—	2.1	—	
	l) Cam wear inlet, µm, *Max*	—	100	—	
	m) Cam wear outlet, µm, *Max*	—	130	—	
	n) Cylinder wear, µm, *Max*	—	5	—	
	p) Bore polishing, percent, *Max*	—	3.5	—	
	q) Timing chain wear, percent, *Max*	—	0.4	—	
	r) Viscosity increase at 100 ºC, percent	—	100	—	
	s) Ring sticking	—	No	—	
	t) Tapet wear inlet, µm, *Max*	—	Rate and report	—	
	u) Tapet wear outlet, µm, *Max*	—	Rate and report	—	
	v) Oil consumption, g/test, *Max*	—	7000	—	

[#] MTAC applicable as detailed in 3.4

Table 5.2 Bench test for EDL7
(*Clauses* 3.1.1 *and* 3.4)

Characteristics	Requirement		Method of Test
Foaming/Settling - 10 min for all sequence, ml/ml			ASTM D892
a) Sequence I	10 / 0		
b) Sequence II	20 / 0		
c) Sequence III	10 / 0		
	SAE 10W-30	SAE 15W-40	
Volatility loss at 250 °C, percent, *Max*	20	18	ASTM D5800
Volatility loss at 371 °C, percent, *Max*	17	15	ASTM D6417
Kinematic viscosity at 100 °C after shearing, mm^2/s, *Min*	SAE XW-30 9.3	SAE XW-40 12.5	ASTM D6278

Table 6.1 Engine Test Sequence for Diesel Engine Oils for EDL8
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	Characteristics	Requirements EDL 8			Method of Test
(1)	(2)	(3)			(4)
		1 test	2 test	3 test	
Caterpillar IP	a) Weighted demerits (WDP), *Max*	350	378	390	ASTM D6681
	b) Top groove carbon (TGC), demerits, *Max*	36	39	41	
	c) Top land carbon (TLC), demerits, *Max*	40	46	49	
	d) Average oil consumption, g/h (0-360 h), *Max*	12.4	12.4	12.4	
	e) Final oil consumption, g/h (312-360 h), *Max*	14.6	14.6	14.6	
	f) Piston, ring and liner scuffing	None	None	None	
OR					
Caterpillar 1R	a) Weighted demerits (WDR), *Max*	382	396	402	ASTM D6923
	b) Top groove carbon (TGC), demerits, *Max*	52	57	59	
	c) Top land carbon (TLC), demerits, *Max*	31	35	36	

	d) Initial oil consumption (IOC), (0 h to 252 h), average, g/h, *Max*	13.1	13.1	13.1	
	e) Final oil consumption (FOC), (432 h to 504 h), average, g/h, *Max*	IOC+1.8	IOC+1.8	IOC+1.8	
	f) Piston, ring and liner distress	None	None	None	
	g) Ring sticking	None	None	None	
Mack T-10 OR	a) Merit rating, *Min*	1000	1000	1000	ASTM D6987 / ASTM 6987M / ASTM D7422
Mack T-12	b) Merit rating, *Min*	1000	1000	1000	
Cummins (M-11) EGR	a) Average crosshead mass loss, mg, *Max*	20	21.8	22.6	ASTM D6975
	b) Average top ring mass loss, mg	Report	Report	Report	
	c) Oil filter differential pressure at 250 h, kPa, *Max*	275	320	341	
	d) Average engine sludge, CRC merits at EOT, *Min*	7.8	7.6	7.5	
OR					
Cummins ISM	a) Crosshead wear, mg, *Max*	7.5	7.8	7.9	ASTM D7468
	b) Oil filter differential pressure at 150 h, kPa, *Max*	55	67	74	
	c) Sludge rating, CRC Merits, *Min*	8.1	8.0	8.0	
Ext. T-8E[1]	Relative viscosity at 4.8 percent soot	1.8	1.9	2.0	ASTM D5967
Sequence IIIF[2]	Kinematic viscosity at 40 °C, percent increase *Max*	275	275[#]	275[#]	ASTM D6984
OR					
Sequence IIIG	Kinematic viscosity, percent increase at 40 °C, *Max*	150	150[#]	150[#]	ASTM D7320
OR					
Sequence IIIH	60 h to 80 h kinematic viscosity, percent increase at 40 °C, *Max*	370	370[#]	370[#]	ASTM D8111
Caterpillar 1K	a) Weighted demerits (WDK), *Max*	332	347	353	ASTM D6750
	b) Top groove fill (TGF), percent, *Max*	24	27	29	
	c) Top land heavy carbon (THLC), percent, *Max*	4	5	5	
	d) Average oil consumption, (0 h to 252 h), g/MJ, *Max*, (0 h to 252 h), (g/kWh), *Max*	0.15 (0.54)	0.15 (0.54)	0.15 (0.54)	
	e) Piston, ring and liner scuffing	None	None	None	
RFWT	Average pin wear, mils, *Max*	0.3	0.33	0.36	ASTM

	(µm), *Max*	7.6	8.4	9.1	D5966
EOAT	Aeration, volume percent, *Max*	8.0	8.0[#]	8.0[#]	ASTM D6894

[#] MTAC applicable as detailed in 3.4

NOTES

[1] A passing T-11 (TGA percent 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.

[2] 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.

Table 6.2 Bench Test for Diesel Engine Oils for EDL8

(*Clauses* 3.1.1 *and* 3.4)

Bench Tests	Characteristic	Requirements	Method of Test
High temperature/ High shear	High temperature/high shear viscosity, at 150 °C, mPa-s, *Min*	3.5	ASTM D4683 / ASTM D4741 / ASTM D5481
MRV-TP-1	Limits are applied to SAE viscosity grades 0W, 5W, 10W and 15W:		ASTM D4684
	Viscosity of 75 h used oil sample from T-10 test (or T-10A test)	25000	
	OR		
	100 h used oil sample from T-12 test (or T-12A test, tested at -20 °C, mPa-s, *Max*	25000	
	If yield stress is detected, use modified D4684 (external pre-heat), then mPa-s, *Max* and yield stress, Pa	<35	
Noack	Evaporative loss at 250 °C, percent, *Max*	15	ASTM D5800
135 °C HTCBT	Copper, mg/kg increase, *Max*	20	ASTM D6594
	Lead, mg/kg increase, *Max*	120	
	Tin, mg/kg increase, *Max*	Report	
	Copper strip rating, *Max*	3	
Viscosity loss due to shear	Kinematic viscosity after shearing, mm^2/s, *Min*	SAE XW-30 (9.3) / SAE XW-40 (12.5)	ASTM D6278
Foaming	Foaming / Settling - 10 min for all sequences, ml/ml, *Max*		ASTM D892
	a) Sequence I	10 / 0	
	b) Sequence II	20 / 0	
	c) Sequence III	10 /0	

Elastomer Compatibility (ASTM D7216)				
Elastomer	**Volume Change, percent**	**Hardness Change, points**	**Tensile Strength Change, percent**	**Elongation at Break Change, percent**
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)

Table 6.3 Engine Test Sequence for Diesel Engine Oils for EDL9
(*Clauses* 3.1.1 *and* 3.4)

Test Sequence	Requirements
Engine tests	Shall pass all the engine tests for EDL8
Mack T 11 test	TGA percent soot at 12.0 mm^2/s increase at 100 °C, *Min* – shall be 6.00
Bench Tests	Shall pass all the bench tests for EDL8

Table 7.1 Engine Test Sequence for Diesel Engine Oils for EDL10
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	Characteristics	Requirements EDL 10			Method of Test
(1)	**(2)**	**(3)**			**(4)**
		1 test	2 test	3 test	
T-12	Merit rating, *Min*	1000	1000	1000	ASTM D7422
ISM	Merit rating, *Min*	1000	1000	1000	ASTM D7468
	Top ring mass loss, mg, *Max*	100	100	100	
C13	Merit rating, *Min*	1000	1000	1000	ASTM D7549
	Hot stuck piston ring	None	None	None	
T-11	TGA percent soot at 4.0 mm^2/s increase, at 100 °C, *Min*	3.5	3.4	3.3	ASTM D7156
	TGA percent soot at 12.0 mm^2/s increase, at 100 °C, *Min*	6.0	5.9	5.9	
	TGA percent soot at 15.0 mm^2/s increase, at 100 °C, *Min*	6.7	6.6	6.5	

ISB	Slider tappet mass loss, average, mg, *Max*	100	108	112	ASTM D7484
	Cam lobe wear, average, µm, *Max*	55	59	61	
	Crosshead mass loss, average, mg	Report	Report	Report	
Caterpillar 1N	Weighted demerits (WDN), *Max*	286.2	311.7	323.0	ASTM D6750
	Top groove fill (TGF), percent, *Max*	20	23	25	
	Top land heavy carbon (THLC), percent, *Max*	3	4	5	
	Oil consumption, (0 h-252 h), g/MJ, *Max* (0 h-252 h), (g/kWh), *Max*	0.15 (0.54)	0.15 (0.54)	0.15 (0.54)	
	Piston, ring and liner scuffing	None	None	None	
	Piston ring sticking	None	None	None	
RFWT	Average pin wear, mils, *Max* (µm) *Max*	0.3 (7.6)	0.33 (8.4)	0.36 (9.1)	ASTM D5966
Sequence IIIF or alternate	Kinematic viscosity at 40 °C, percent increase, *Max*	275	275#	275#	ASTM D6984
Sequence IIIG	Kinematic viscosity at 40 °C, percent increase, *Max*	150	150#	150#	ASTM D7320
OR					
Sequence IIIH	60 h to 80 h Kinematic viscosity, percent increase at 40 °C, *Max*	370	370#	370#	ASTM D8111
OR					
Sequence IIIH70	70 h Kinematic viscosity, percent increase at 40 °C, *Max*	370	370#	370#	ASTM D8111
EOAT	Aeration volume, percent, *Max*	8.0	8.0#	8.0#	ASTM D6894

MTAC applicable as detailed in 3.4

Table 7.2 Bench Test for Diesel Engine Oils for EDL10
(*Clauses* 3.1.1 *and* 3.4)

Bench Tests	Characteristics	Primary Requirements	Method of Test
High temperature/ High shear	High temperature/high shear viscosity at 150 °C, mPa-s, *Min*	3.5	ASTM D4683 / ASTM D4741 / ASTM D5481

MRV-TP-1	Viscosity of the 180 h used oil drain sample from a T-11 test, tested at -20 °C, mPa-s, *Max*	25000	ASTM D6896
	If yield stress is detected, use modified D4684 (external pre-heat), then mPa-s, *Max* and yield stress, Pa	<35	
Noack	Evaporative loss at 250 °C, percent, *Max* (viscosity other than SAE 10W-30)	13	ASTM D5800
	Evaporative loss at 250 °C, percent, *Max* (SAE 10W-30 viscosity)	15	
HTCBT	Copper, mg/kg increase , *Max*	20	ASTM D6594
	Lead, mg/kg increase , *Max*	120	
	Copper strip rating, *Max*	3	
Viscosity Loss due to shear	Kinematic viscosity after 90 pass shearing, mm^2/s at 100°C, *Min*	SAE XW-30 (9.3) / SAE XW-40 (12.5)	ASTM D7109
Foaming	Foaming / Settling – 10 min for each sequence, ml/ml, *Max* a) Sequence I b) Sequence II c) Sequence III	 10 / 0 20 / 0 10 / 0	ASTM D892

Chemical Requirements (Non-Critical)		
Chemicals	**Requirement**	**Method of Test**
Sulphated ash, *m*/*m* percent, *Max*	1.0	ASTM D874
Phosphorous, *m*/*m* percent, *Max*	0.12	ASTM D4951
Sulphur, *m*/*m* percent, *Max*	0.4	ASTM D4951

Elastomer Compatibility (ASTM D7216)				
Elastomer	**Volume Change, percent**	**Hardness Change, points**	**Tensile Strength Change, percent**	**Elongation at Break Change, percent**
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, -TMC1006)
Vamac G	(+TMC 1006, -3)	(+5, -TMC 1006)	(+10, -TMC 1006)	(+10, -TMC 1006)

Table 8.1 Engine Test Sequence for Diesel Engine Oils for EDL11 and EDL 12
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	Characteristics	Requirements EDL 11 & EDL 12			Method of Test
(1)	(2)	(3)			(4)
	Test Run	1 test	2 test	3 test	
T-12	Top ring mass loss, mg, *Max* in T-12	105	105	105	ASTM D7422
	Cylinder liner wear, µm, *Max*	24.0	24.0	24.0	
T-13	IR Peak at EOT, Absorbance, cm^{-1}	125	130	133	ASTM D8048
	Kinematic viscosity increase at 40 °C, percent, *Max*	75	85	90	
	Average oil consumption, 48 h to 192 h, g/h	Report	Report	Report	
T-11	TGA percent soot at 4.0 mm^2/s, increase at 100 °C, *Min*	3.5	3.4	3.3	ASTM D7156
	TGA percent soot at 12.0 mm^2/s, increase at 100 °C, *Min*	6.0	5.9	5.9	
	TGA percent soot at 15.0 mm^2/s, increase at 100 °C, *Min*	6.7	6.6	6.5	
C13	Merit rating, *Min*	1000	1000	1000	ASTM
COAT	Average aeration, 40 h to 5 0h, percent, *Max*	11.8	11.8	11.8	ASTM D8047
ISB	Slider tappet mass loss, mg, average, *Max*	100	108	112	ASTM D7484
	Cam lobe wear, µm, average, *Max*	55	59	61	
	Crosshead mass loss, mg, average	Report	Report	Report	
ISM	Top ring mass loss, mg, *Max*	100	100	100	ASTM D7468
	Merit rating, *Min*	1000	1000	1000	
Caterpillar 1N	Weighted demerits (WDN), *Max*	286.2	311.7	323	ASTM D6750
	Top groove fill (TGF), percent, *Max*	20	23	25	
	Top land heavy carbon (THLC), percent, *Max*	3	4	5	
	Oil Consumption, (0 h to 252h), g/MJ, *Max* (0 h to 252 h), (g/kWh), *Max*	0.15	0.15	0.15	
	Piston, ring and liner scuffing	None	None	None	
	Piston ring sticking	None	None	None	
RFWT	Average pin wear, mils, *Max*	0.3	0.33	0.36	ASTM D5966
	(µm), *Max*	(7.6)	(8.4)	(9.1)	

Table 8.2 Bench Test for Diesel Engine Oils for EDL11 and EDL 12
(*Clauses* 3.1.1 *and* 3.4)

Characteristics	Primary Requirements		Method of Test
	EDL 11	EDL 12	
Applicable SAE J300 Viscosity	SAE xW-30	SAE xW-30	

High temperature / high shear, mPa.s			ASTM D4683 / ASTM D4741 / ASTM D5481
xW-30 grades, *Min*	3.5	2.9	
xW-30 grades, *Max*	Not Applicable	3.2	
xW-40 grades	Shall meet SAE J300	Not Applicable	
HTCBT			ASTM D6594
Copper, mg/kg increase, *Max*	20	20	
Lead, mg/kg increase, *Max*	120	120	
Copper strip rating, *Max*	3	3	
Kinematic viscosity at 100 °C after 90 pass shearing, mm^2/s, *Min*			ASTM D445
xW-30	9.3	9.3	
0W-40	12.5	Not Applicable	
Other xW-40	12.8	Not Applicable	
HTHS viscosity at 150 °C after 90 pass shearing, mPa.s, *Min* xW-30 grades	3.4	2.8	ASTM D7109
Evaporative loss at 250 °C, percent, *Max*	13	13	ASTM D5800
Foaming / Settling –10 min for each sequence, ml, *Max* a) Sequence I b) Sequence II c) Sequence III	 10 / 0 20 / 0 10 / 0	 10 / 0 20 / 0 10 / 0	ASTM D892
Sooted oil MRV TP-1			ASTM D6896
Viscosity of the 180 h used oil drain sample from a T-11 test, tested at -20 °C, mPa-s, *Max*	25000	25000	
Yield stress of the 180 h used oil sample above, Pa, *Max*	≤35	≤35	

Chemical Requirements (Non-Critical)			
Chemicals	**Requirements**		**Method of Test**
	EDL11	**EDL12**	
Sulphated ash, percent, *m*/*m*, *Max*	1.0	1.0	ASTM D874
Phosphorous, percent, *m*/*m*, *Max*	0.12	0.12	ASTM D4951

Sulphur, percent, *m/m, Max*	0.4	0.4	

Elastomer Compatibility (ASTM D7216)				
Elastomer	**Volume Change, percent**	**Hardness Change, Points**	**Tensile Strength Change, percent**	**Elongation at Break Change, percent**
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)

Table 9.1 Engine Test Sequence for Petrol Engine Oils
(*Clauses* 3.1.2 *and* 3.4)

Test Technique	**Characteristics**	**Requirements**		**Method of Test**
		EPL 3[1]	**EPL 4**	
(1)	**(2)**	**(3)**	**(4)**	**(5)**
CRC L38	a) Bearing weight loss, mg, *Max*	40	40	ASTM D5119
	b) Piston skirt varnish, *Min*	9.0	—	
	c) Shear stability	Stay in Grade (Refer to Table 11.3A)		
OR				
Sequence VIII	a) Bearing weight loss, mg, *Max*	26.4	26.4	ASTM D6709
	b) Shear stability	Stay in Grade (Refer to Table 11.3A)		
Sequence IID	a) Average engine rust rating, *Min*	8.5	8.5	ASTM D5844
	b) Number stuck lifters	None	None	
OR				
BRT	Average grey value, *Min*	100	100	ASTM D6557
Sequence IIIE	a) Average piston varnish rating, *Min*	8.9	8.9	ASTM D5533
	b) Average oil ring land deposits, *Min*	3.5	3.5	
	c) Average engine sludge rating, *Min*	9.2	9.2	
	d) Hours to 375 percent kinematic viscosity increase (at 40 °C), *Min*	64	64	

	e) Cam plus lifter wear, mm:			
	1) Average, *Max*	0.064	0.064	
	2) Maximum, *Max*	0.030	0.030	
	f) Lifter sticking	None	None	
	g) Cam or lifter scuffing	None	None	
	h) Ring sticking (oil related)	None	None	
OR				
Sequence IIIF	a) Kinematic viscosity, percent increase at 40 °C, *Max*	—	325	ASTM D6984
	b) Average piston skirt varnish rating, *Min*	—	8.5	
	c) Weighted piston deposit rating, *Min*	—	3.2	
	d) Screened average cam-cum-lifter wear, mm, *Max*	—	0.020	
	e) Hot stuck rings	—	None	
OR				
Sequence IIIG	Kinemic viscosity, percent increase at 40 °C, *Max*	—	150	ASTM D7320
	Weighted piston deposit rating, *Min*	—	3.5	
	Cam plus lifter wear average, µm, *Max*	—	60	
	Hot stuck rings	—	None	
OR				
Sequence IIIH	60 h kinematic viscosity, percent increase at 40 °C, *Max*	—	307	ASTM D8111
	70 h average weighted piston deposits, merits, *Min*	—	2.5	
	70 h average piston skirt varnish, merits, *Min*	—	7.5	
Sequence VE	a) Average engine sludge rating, *Min*	9.0	9.0	ASTM D5302
	b) Rocker arm cover sludge rating, *Min*	7.0	7.0	
	c) Average engine varnish rating, *Min*	5.0	5.0	
	d) Average piston skirt varnish rating, *Min*	6.5	6.5	
	e) Cam wear:			
	1) Average, *Max*	0.380	0.380	
	2) Maximum, *Max*	0.127	0.127	
	f) Oil ring clogging, percent, *Max*	Report	Report	
	g) Oil screen clogging, percent, *Max*	20.0	20.0	
	h) Compression ring sticking (hot stuck)	None	None	
OR Sequence IVA plus Sequence VG				

Sequence IVA	Cam wear average, µm, *Max*	—	120	ASTM D6891
Sequence VG	a) Average engine sludge rating, *Min*	—	7.8	ASTM D6593
	b) Rocker arm cover sludge rating, *Min*	—	8.0	
	c) Average piston skirt varnish, rating, *Min*	—	7.5	
	d) Average engine varnish rating, *Min*	—	8.9	
	e) Oil screen clogging, percent, *Max*	—	20	
	f) Hot stuck compression ring	—	None	
OR Sequence IVA plus Sequence VH				
Sequence VH	a) Average engine sludges, merits, *Min*	—	7.4	ASTM D8256
	b) Average rocker cover sludge, merits, *Min*	—	7.4	
	c) Average engine varnish, merits, *Min*	—	8.6	
	d) Average piston skirt varnish, merits, *Min*	—	7.4	
	e) Oil screen clogging, percent area	—	Rate and report	
	f) Hot stuck compression rings	—	None	

[1] EPL3 is applicable for defence applications only

Table 9.2 Compositional and Bench Test Requirements (Petrol Engine Oils) for EPL 3 and EPL 4

(*Clauses* 3.1.2 *and* 3.4)

Characteristics/ PCMO Performance Category	**Primary Requirements**			**Method of Test**
	EPL 3	**EPL 4**		
		SAE 0W-20, 5W-20, 5W-30, 10W-30	**All Other Viscosity Grades**	
(1)	**(2)**	**(3)**	**(4)**	**(5)**
Phosphorous Content[1], percent by mass, *Max*	0.12	0.12	0.12	IS 1448 (Part 54)
TEOST high temperature deposits, mg, *Max*	—	60	60	ASTM D6335
Gelation index[1], *Max*	—	12	Not Required	ASTM D5133
HTHS viscosity at 150 °C, mPa-s, *Min*	—	Not Required	2.6	ASTM D4683 / ASTM D4741 / ASTM D5481
Volatility[2] loss, percent, *Max*	—	22	20	ASTM D5800
OR				
Volatility[2] loss at 371 °C, percent,	—	17	15	ASTM D6417

Max				
OR				
Volatility[2] loss at 371 °C, percent *Max*	—	17	15	ASTM D5480
(EOFT), percent flow reduction, *Max*	—	50	50	ASTM D6795
Phosphorus, *m/m*, percent, *Max*	—	0.10	Not Required	ASTM D4951 / ASTM D5185
Phosphorus, *m/m*, percent, *Min* (unless valid results from ASTM D5302 are obtained)	—	0.06	0.06	
Foaming tendency (Option A), *Max*	—			ASTM D892
Sequence I	—	10 / 0		
Sequence II	—	50 / 0		
Sequence III	—	10 / 0		
Static foam, tendency/stability, *Max* (optional blending required)	—	200/50	200/50	ASTM D6082
Homogeneity and miscibility	—	Homogeneous with SAE reference oil	Homogeneous with SAE reference oil	ASTM D6922

NOTES
[1] Phosphorous content and gelation index limits applicable to 0W-20, 5W-20, 5W-30 and 10W-30 viscosity grades only.
[2] Passing volatility loss only required for SAE 15W-40 oils.

Table 10.1 Engine Test Sequence for Petrol Engine Oils for EPL 5
(*Clauses* 3.1.2 *and* 3.4)

Test Technique	**Characteristics**	**Primary Requirements EPL5**	**Method of Test**
(1)	**(2)**	**(3)**	**(4)**
Sequence IIIF	a) Kinematic viscosity, percent increase at 40 °C, *Max*	275	ASTM D6984
	b) Average piston skirt varnish rating, *Min*	9.0	
	c) Weighted piston deposit rating[1], *Min*	4.0	
	d) Screened average cam-cum-lifter wear, µm, *Max*	20[2]	
	e) Hot stuck rings	None	
	f) Low temperature viscosity performance, mPa-s[3]	Report	ASTM D4684 / ASTM D5293
OR			

Sequence IIIG	a) Kinematic viscosity, percent increase at 40 °C, *Max*	150	ASTM D7320
	b) Weighted piston deposit rating, *Min*	3.5	
	c) Cam plus lifter wear, µm, *Max*	60	
	d) Hot stuck rings	None	
	e) Low temperature viscosity performance[4]	Report	ASTM D4684
Sequence IIIH	a) 70 h kinematic viscosity, percent increase at 40 °C, *Max*	181	ASTM D8111
	b) 70 h average weighted piston deposits, merits, *Min*	3.3	
	c) 70 h average piston skirt varnish, merits, *Min*	7.9	
Sequence IVA	Cam wear average, µm, *Max*	120	ASTM D6891
Sequence VE[1]	a) Cam wear average, µm, *Max*	127	ASTM D5302
	b) Cam wear max, µm, *Max*	380	
Sequence VG	a) Average engine sludge rating, *Min*	7.8	ASTM D6593
	b) Rocker arm cover sludge rating, *Min*	8.0	
	c) Average piston skirt varnish rating, *Min*	7.5	
	d) Average engine varnish rating, *Min*	8.9	
	e) Oil screen clogging, percent, *Max*	20	
	f) Compression ring sticking (hot stuck)	None	
	g) Cold stuck rings	Report	
	h) Oil screen debris, percent	Report	
	j) Oil ring clogging, percent	Report	
OR			
Sequence VH	a) Average engine sludge, merits, *Min*	7.4	ASTM D8256
	b) Average rocker cover sludge, merits, *Min*	7.4	
	c) Average engine varnish, merits, *Min*	8.6	
	d) Average piston skirt varnish, merits, *Min*	7.4	
	e) Oil screen clogging, percent area	Rate and Report	
	f) Hot stuck compression rings	None	
Sequence	a) Bearing weight loss, mg, *Max*	26.4	ASTM D6709

VIII	b) Shear stability	Refer Table 11.3A	ASTM D6278

NOTES

[1] Not required for oils containing a minimum of 0.06 percent mass phosphorous in the form of ZDDP.

[2] Calculate by eliminating the highest and lowest cam-plus-lifter wear result and then calculating an average based on the remaining ten rating positions.

[3] Evaluate the 80 h test oil sample by test Method ASTM D4684 at the temperature indicated by the low temperature grade of oil as determined on the 80 h sample by Test Method ASTM D5293.

[4] Measure the viscosity of the EOT oil sample by Test Method ASTM D4684 in mPa-s. The measured viscosity shall meet the requirements of the original grade or the next higher grade.

Table 10.2 Bench Tests of EPL 5

(*Clauses* 3.1.2 *and* 3.4)

Characteristics	**SAE 0W-20, 5W-20, 5W-30, 10W-30**	**Other Viscosity Grades**	**Method of Test**
High temperature/high shear at 150 °C, *Min*, mPa-s	As per SAE J300		ASTM D4683 / ASTM D4741 / ASTM D5481
Ball rust test, average grey value, *Min*	100	100	ASTM D6557
Volatility loss, percent, *Max*	15	15	ASTM D5800
Volatility loss at 371 °C, percent, *Max*	10	10	ASTM D6417
EOFT, percent flow reduction, *Max*	50	50	ASTM D6795
EOWTT, percent flow reduction, *Max*			
With 0.6 percent H_2O	50	50	
With 1.0 percent H_2O	50	50	
With 2.0 percent H_2O	50	50	
With 3.0 percent H_2O	50	50	
Phosphorus, *m*/*m*, percent, *Max*	0.10	Not Required	ASTM D4951 / ASTM D5185
Phosphorus, *m*/*m*, percent, *Min*	0.06	0.06	
Foaming tendency, foaming/settling, ml/ml, *Max*			ASTM D892
a) Sequence I	10 / 0	10 / 0	
b) Sequence II	50 / 0	50 / 0	
c) Sequence III	10 / 0	10 / 0	
Static foam, tendency / stability, *Max*	100 / 0	100 / 0	ASTM D6082
Homogeneity and miscibility	Homogeneous with SAE reference oil		ASTM D6922

High temperature deposit (TEOST MHT-4), mg, *Max*	45	45	ASTM D7097
Gelation index, *Max*[1]	12[2]	12[2]	ASTM D5133

NOTES
[1] Requirement applies only to SAE 0W-20, 5W-20, 0W-30, 5W-30 and 10W-30 viscosity grades
[2] For gelation temperature at or above the W grade pump ability temperature as defined in SAE J300

Table 11.1 Engine Test Sequence for Petrol Engine Oils for EPL6 and EPL 7
(*Clauses* 3.1.2 *and* 3.4)

Test Technique	**Characteristics**	**Requirements**					**Method of Test**
		EPL 6		**EPL 7**		**EPL7 with Resource**	
(1)	**(2)**	**(3)**		**(4)**		**(5)**	**(6)**
		SAE 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	All others	SAE 0W-16, 5W-16, 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	All others	All viscosity grades	
Sequence IIIG		Pass	Pass	Pass	Pass	Pass	ASTM D7320
	Kinematic viscosity, percent increase at 40°C, *Max*	150	150	150	150	150	
	Weighted piston deposit rating, *Min*	3.5	3.5	4	4	4	
	Cam plus lifter wear, µm, *Max*	60	60	60	60	60	
	Hot stuck rings	None	None	None	None	None	
OR							
Sequence IIIH	Kinematic viscosity, percent increase at 40 °C, *Max*	150	150	150	150	150	ASTM D8111
	Average weighted piston deposits, merits, *Min*	3.2	3.2	3.7	3.7	3.7	
	Hot stuck rings	None	None	None	None	None	

Sequence IIIGA	Low temperature viscosity performance	Pass	Not Required	Refer bench test			ASTM D4684
OR							
ROBO test (MRV TP-1)	Low temperature viscosity performance	Pass	Not Required	-	-	-	ASTM D4684
OR							
Sequence IIIHA	Low temperature viscosity performance	Pass	Not Required	-	-	-	
Sequence IVA	Cam wear average, µm, *Max*	90	90	90	90	90	ASTM D6891
Sequence VG		Pass	Pass	Pass	Pass	Pass	ASTM D6593
	Average engine sludge rating, *Min*	7.8	7.8	8.0	8.0	8.0	
	Rocker arm cover sludge rating, *Min*	8.0	8.0	8.3	8.3	8.3	
	Average piston skirt varnish rating, *Min*	7.5	7.5	7.5	7.5	7.5	
	Average engine varnish rating, *Min*	8.9	8.9	8.9	8.9	8.9	
	Oil screen sludge, percent area, *Max*	20	20	15	15	15	
	Oil screen debris, percent	Report	Report	Report	Report	Report	
	Compression ring sticking (hot stuck)	None	None	None	None	None	
	Cold stuck rings	Report	Report	Report	Report	Report	
	Oil ring clogging, percent	Report	Report	Report	Report	Report	
OR							
Sequence VH		Pass	Pass	Pass	Pass	Pass	
	Average engine sludge, merits, *Min*	7.4	7.4	7.6	7.6	7.6	
	Average rocker cover sludge, merits, *Min*	7.4	7.4	7.7	7.7	7.7	
	Average engine varnish, merits, *Min*	8.6	8.6	8.6	8.6	8.6	

	Average piston skirt varnish, merits, *Min*	7.6	7.6	7.6	7.6	7.6	
	Oil screen clogging, percent area	Report	Report	Report	Report	Report	
	Hot stuck compression rings	None	None	None	None	None	
Sequence VID		Not Require	Not Requi	Not Require	Not Required	Pass	ASTM D7589
	For SAE xW-16 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	2.8	
	FEI 2, percent after 100h aging, *Min*	—	—	—	—	1.3	
	For SAE xW-20 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	2.6	
	FEI 2, percent after 100h aging, *Min*	—	—	—	—	1.2	
	For SAE xW-30 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	1.9	
	FEI 2, percent after 100h aging, *Min*	—	—	—	—	0.9	
	For SAE 10W-30 and all other viscosity grade						
	FEI 2, percent after 100h aging, *Min*	—	—	—	—	1.5	
	For SAE 10W-30 and all others, FEI SUM, percent, *Min*	—	—	—	—	0.6	
OR							
Sequence VIF		Not Required	Not Requi red	Not Required	Not Required	Pass	ASTM D8226
	For SAE xW-16 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	3.7	
	FEI 2, percent after 100 h aging, *Min*	—	—	—	—	1.8	

Sequence VIE		Not Required	Not Required	Not Required	Not Required	Pass	ASTM D8114
	For SAE xW-20 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	3.2	
	FEI 2, percent after 125 h aging, *Min*	—	—	—	—	1.5	
	For SAE xW-30 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	2.5	
	FEI 2, percent after 125 h aging, *Min*	—	—	—	—	1.2	
	For SAE 10W-30 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	2.2	
	FEI 2, percent after 125 h aging, *Min*	—	—	—	—	1.0	
Sequence VIF		Not Required	Not Required	Not Required	Not Required	Pass	ASTM D8226
	For SAE xW-16 viscosity grade						
	FEI SUM, percent, *Min*	—	—	—	—	3.7	
	FEI 2, percent after 125 h aging, *Min*	—	—	—	—	1.8	
Sequence VIII	Bearing weight loss, mg, *Max*	26	26	26	26	26	ASTM D6709

Table 11.2 Bench tests of EPL 6
(*Clauses* 3.1.2 *and* 3.4)

Characteristics	**SAE 0W-20, 5W-20, 0W-30, 5W-30, 10W-30**	**Other Viscosity Grades**	**Method of Test**
(1)	**(2)**	**(3)**	**(4)**
Ball rust test, average gray value, *Min*	100	100	ASTM D6557
Volatility loss, percent, *Max*	15	15	ASTM D5800
Simulated distillation at 371 °C, percent, *Max*	10	10	ASTM D6417
EOFT, percent flow reduction, *Max*	50	50	ASTM D6795
EOWTT, percent flow reduction, *Max*			ASTM D6794

With 0.6 percent H_2O	50	50	
With 1.0 percent H_2O	50	50	
With 2.0 percent H_2O	50	50	
With 3.0 percent H_2O	50	50	
Phosphorus, *m*/*m*, percent, *Max*	0.08	Not Required	ASTM D4951
Phosphorus, *m*/*m*, percent, *Min*	0.06	0.06	
Sulphur, *m*/*m*, percent, *Max*			
0W-20, 5W-20, 0W-30,5W-30	0.5	Not Required	ASTM D4951 / ASTM D2622
10W-30	0.7	Not Required	
Foaming tendency, foaming/settling, ml/ml, *Max*			ASTM D892
a) Sequence I	10 / 0	10 / 0	
b) Sequence II	50 / 0	50 / 0	
c) Sequence III	10 / 0	10 / 0	
High temperature foaming, tendency /stability, *Max*	100 / 0	100 / 0	ASTM D6082
Homogeneity and miscibility	Homogeneous with ASTM reference oil		ASTM D6922
(Sequence VIII) Shear Stability	Refer Table 11.3A		ASTM D6709
OR			
Shear Stability (30 Passes)	Refer Table 11.3A		ASTM D6278
High temperature deposit (TEOST MHT), mg, *Max*	35	45	ASTM D7097
Gelation index, *Max*	12[1]	Not Required	ASTM D5133

NOTES
[1] To be evaluated from -5 °C to the temperature at which 40000cP is attained or -40 °C or 2 °C below the appropriate MRV TP-1 temperature, whichever occurs first.

Table 11.3 Bench tests of EPL 7
(*Clauses* 3.1.2 *and* 3.4)

Characteristics	**EPL 7**		**EPL 7 with Resource Conserving**	**Method of Test**
	SAE 0W-16, 5W-16, 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	**Other Viscosity Grades**	**All Viscosity Grades**	
Aged oil low-temperature viscosity, Sequence IIIGA	Pass	Pass	Pass	ASTM D4684
OR				

Aged oil low-temperature viscosity, ROBO test	Pass	Pass[1]	Pass[1]	ASTM D7528
Sequence IIIGB P retention percent, *Min*	Not Required	Not Required	79	ASTM D7320
OR				
Sequence IIIHB P retention percent, *Min*	Not Required	Not Required	81	ASTM D7320
High temperature/high shear viscosity at 150 °C, mPa-s, *Min*	2.3	2.6	2.3	ASTM D4683 / ASTM D4741 / ASTM D5481
Ball rust test, average grey value, *Min*	100	100	100	ASTM D6557
Volatility loss, percent *Max*	15	15	15	ASTM D5800
Simulated distillation at 371°C, percent, *Max*	10	10	10	ASTM D6417
EOFT, percent flow reduction, *Max*	50	50	50	ASTM D6795
EOWTT, percent flow reduction, *Max*				
With 0.6 percent H_2O	50	50	50	ASTM D6794
With 1.0 percent H_2O	50	50	50	
With 2.0 percent H_2O	50	50	50	
With 3.0 percent H_2O	50	50	50	
Catalyst compatibility				
Phosphorus, *m*/*m*, percent	0.06 to 0.08	0.06, *Min*[1]	0.06 to 0.08	ASTM D4951 / ASTM D5185
Sulphur, *m*/*m*, percent, *Max*				ASTM D4951 / ASTM D2622
0W-16, 0W-20, 5W-20,5W-16 0W-30,5W-30	0.5[2]	Not Required	0.5[2]	
10W-30	0.6[2]	Not Required	0.6[2]	
All other viscosity grades	Not Required	Not Required	0.6[2]	
Foaming tendency, foaming/settling, ml/ml, *Max*				ASTM D892
a)Sequence I	10 / 0	10 / 0	10 / 0	

b) Sequence II	50 / 0	50 / 0	50 / 0	
c) Sequence III	10 / 0	10 / 0	10 / 0	
High temperature foaming, tendency /stability, *Max*	100 / 0	100 / 0	100 / 0	ASTM D6082
Homogeneity and miscibility	Homogeneous with ASTM reference oil			ASTM D6922
(Sequence VIII) Shear stability	Refer Table 11.3A			ASTM D6709
OR				
Shear stability (30 Passes)	Refer Table 11.3A		-	ASTM D6278
High temperature deposit (TEOST MHT), mg, *Max*	35	45	35	ASTM D7097
Gelation index, *Max*	12[3]	Not Required	12[3]	ASTM D5133
High temperature deposit (TEOST 33C), Total deposit weight, mg, *Max*	Not Required	Not Required	Not Required	ASTM D6335
SAE 0W-20	Not Required	Not Required	Not Required	
All other viscosity grades	Not Required	Not Required	30	
Emulsion retention	Not Required	Not Required	No water separation	ASTM D7563

NOTES
[1] Not required for mono grade and 15W, 20W, and 25W multigrades.
[2] 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 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 when CK-4 and 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.
[3] To be evaluated from -5 °C to the temperature at which 40000cP is attained or -40 °C or 2 °C below the appropriate MRV TP-1 temperature, whichever occurs first.

Table 11.3A Requirements of CRC L-38/Sequence VIII / ASTM D6278 (30 Passes) Tests Stay-In-Grade

(*Clause*s 3.1.2, 3.4; *and applicable for shear stability tests mentioned in Tables* 9.1, 10.1, 11.2, 11.3 *and* 13.2)

Viscosity Grade	**10 h Stripped Kinematic Viscosity at 100 °C, mm²/s, *Min* (L-38/Sequence VIII)**	**Kinematic viscosity at 100 °C, mm²/s, *Min* (ASTM D6278)**
(1)	**(2)**	**(3)**
XW-16	6.1	5.8

XW-20	6.9	6.5
XW-30	9.3	8.5
XW-40	12.5	11.5
XW-50	16.3	15.0
XW-60	21.9	19.8

Table 12.1 Engine Tests Requirement for EPL 8
(*Clauses* 3.1.2 *and* 3.4)

Characteristics	EPL8		EPL8 with Resource Conserving	Method of Test
	SAE 0W-16, 5W-16, 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	Other Viscosity Grades	All Viscosity Grades	
All engine tests as per EPL 7	Pass	Pass	Pass	
Sequence IX, average numbers of events, *Max*	5	5	5	ASTM D8291

Table 12.2 Bench Tests Requirement for EPL 8
(*Clauses* 3.1.1 *and* 3.4)

Characteristics	EPL8	EPL 8 with Resource Conserving
	Requirements	Requirements
All bench tests as per EPL 7	Pass	Pass

Table 13.1 Engine Tests Requirement for EPL 9
(*Clauses* 3.1.1 *and* 3.4)

Test Technique	Characteristics	EPL 9		EPL9 with Resource Conserving	Method of Test
		SAE 0W-16, 5W-16, 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	Other Viscosity Grades	All Viscosity Grades	
Sequence IIH	Kinematic viscosity, percent increase at 40°C, *Max*	100	100	100	ASTM D8111
	Average weighted piston deposits, merits, *Min*	4.2	4.2	4.2	
	Hot stuck rings	None	None	None	
Sequence IVB	Average intake lifter volume loss, mm^3, *Max*	2.7	2.7	2.7	ASTM D8350
	End of test iron, ppm,	400	400	400	ASTM

	Max				D8256
Sequence VH	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, percent area	Report	Report	Report	
	Oil screen debris, percent area	Report	Report	Report	
	Hot – stuck compression rings	None	None	None	
	Cold stuck rings	Report	Report	Report	
	Clogging, percent area	Report	Report	Report	
Sequence VIE					
	For SAE xW-20 viscosity grade				ASTM D8114
	FEI SUM, percent, *Min*	—	—	3.8	
	FEI 2, percent after 125 h aging, *Min*	—	—	1.8	
	For SAE xW-30 viscosity grade				
	FEI SUM, percent, *Min*	—	—	3.1	
	FEI 2, percent after 125 h aging, *Min*	—	—	1.5	
	For SAE 10W-30 viscosity grade and all other grades				
	FEI SUM, percent, *Min*	—	—	2.8	
	FEI 2, percent after 125 h aging, *Min*	—	—	1.3	
Sequence VIF	For SAE xW-16 viscosity grade				ASTM D8226
	FEI SUM, percent, *Min*	—	—	4.1	
	FEI 2, percent after 125 h aging, *Min*	—	—	1.9	
Sequence VIII	For SAE XW-16	Not Required	Not Required	Not Required	ASTM D6709
	Bearing weight loss, mg, *Max* (For all viscosity grades)	26	26	26	
Sequence IX	Average of events for four iterations, *Max*	5	5	5	ASTM D8291
	Number of events per iteration, *Max*	8	8	8	
Sequence X	Percent increase, *Max*	0.085	0.085	0.085	ASTM D8279

Table 13.2 Bench Tests Requirement for EPL 9
(*Clauses* 3.1.1 *and* 3.4)

Characteristics	**EPL 9**		**EPL 9 with Resource Conserving**	**Method of Test**
	SAE 0W-16, 5W-16, 0W-20, 5W-20, 0W-30, 5W-30, 10W-30	**Other Viscosity Grades**	**All Viscosity Grades**	
(1)	**(2)**	**(3)**	**(4)**	**(5)**
Aged oil low-temperature viscosity, (Sequence IIIHA)	Pass[1]	Pass	Pass	ASTM D8111
Measure aged oil low temperature viscosity on final formulation—this includes base oil and additive combination being licensed—for each viscosity grade by either IIIHA or ROBO	Pass	Pass	Pass	ASTM D4684 (MRV TP-1)
Measure CCS viscosity of EOT IIIHA or ROBO sample at CCS temperature corresponding to original viscosity grade	Pass	Pass	Pass	As per SAE J300
OR				
ROBO test, aged oil low-temperature viscosity	Pass	Pass	Pass	ASTM D7528
Measure aged oil low temperature viscosity on final formulation—this includes base oil and additive combination being licensed—for each viscosity grade by either IIIHA or ROBO				ASTM D4684 (MRV TP-1)
Measure CCS viscosity of EOT IIIHA or ROBO sample at CCS temperature corresponding to original viscosity grade				As per SAE J300
High temperature/high shear viscosity at 150 °C, mPa-s, *Min*	2.3	2.3	2.3	ASTM D4683 / ASTM D4741 / ASTM D5481
Ball rust test, average gray value, *Min*	100[2]	100[2]	100[2]	ASTM D6557

Evaporation loss, 1 hr at 250 °C, percent, *Max*	15	15	15	ASTM D5800
EOFT, percent flow reduction, *Max*	50	50	50	ASTM D6795
EOWTT, percent flow reduction, *Max*				ASTM D6794
With 0.6 percent H_2O	50	50	50	
With 1.0 percent H_2O	50	50	50	
With 2.0 percent H_2O	50	50	50	
With 3.0 percent H_2O	50	50	50	
Phosphorus, *m/m*, percent	0.08 to 0.06[3]	0.06, *Min*[3]	0.08 to 0.06[3]	ASTM D4951 / ASTM D5185
Sulphur, *m/m*, percent, *Max*	0.5 (For 10W-30 is 0.6)[4)]	Not Required	0.5 (For 10W-30 is 0.6)[4)]	ASTM D4951 / ASTM D5185 / ASTM D2622
Foaming tendency, foaming/settling, ml/ml, *Max*				ASTM D892
Sequence I	10 / 0	10 / 0	10 / 0	
Sequence II	50 / 0	50 / 0	50 / 0	
Sequence III	10 / 0	10 / 0	10 / 0	
High temperature foaming, tendency /stability, *Max*	100 / 0	100 / 0	100 / 0	ASTM D6082
Homogeneity and miscibility	Homogeneous with ASTM reference oil			ASTM D6922
(Sequence VIII) Shear stability	Refer Table 11.3A			ASTM D6709
OR				
Shear stability (30 Passes)	Refer Table 11.3A			ASTM D6278
Gelation index, *Max*[2]	12[4]	Not Required	12[4]	ASTM D5133
High temperature deposit (TEOST 33C), total deposit weight, mg, *Max*	Not Required	Not Required	30, Not Required (for SAE 0W-20 and XW-16)	ASTM D6335
Emulsion retention	Not Required	Not Required	No water separation	ASTM D7563

NOTES

[1] Not required for mono grade and 15W, 20W and 25W multigrades.

[2] 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.

[3] 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 phosphorus limit in the "SP with "Resource Conserving" column (0.08 percent 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.

[4]To be evaluated from -5 °C to the temperature at which 40000 cP is attained or -40 °C or 2 °C below the appropriate MRV TP-1 temperature, whichever occurs first.

Table 13.3 Seal Tests Requirement for EPL 9

(*Clauses* 3.1.1 *and* 3.4)

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. The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed herein.				
Elastomer Material (SAE J2643)	**Test Procedure**	**Material Property**	**Units**	**Limits**
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	percent Δ	-5, 9
	ASTM D2240	Hardness	points	-10, 10
	ASTM D412	Tensile Strength	percent Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	percent Δ	-5, 10
	ASTM D2240	Hardness	points	-10, 5
	ASTM D412	Tensile Strength	percent Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	percent Δ	-5, 40
	ASTM D2240	Hardness	points	-30, 10
	ASTM D412	Tensile Strength	percent Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	percent Δ	-2, 3
	ASTM D2240	Hardness	points	-6, 6
	ASTM D412	Tensile Strength	percent Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	percent Δ	-5, 30
	ASTM D2240	Hardness	points	-20, 10
	ASTM D412	Tensile Strength	percent Δ	-30, 30

Table 14 Requirement for Physico-Chemical Properties (other than viscosity)

[*Clause* 4.2.2 (a) ,4.2.2 (b) *and* 7.2]

Sl. no	**Characteristics**	**Requirement for Grade**												**Method of Test**
		SAE	SAE	SAE	SAE	SAE	SAE	SAE	SAE	SAE	SAE	SAE	Multi-Grade	
		0W	5W	10W	15W	20W	25W	20	30	40	50	60		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
i)	Appearance	When examined in transmitted light in a colourless glass test-tube of 25 mm internal diameter, oil shall be clear, bright and free from turbidity and sediment												Visual
ii)	Viscosity index, *Min*	100	100	100	95	95	95	95	95	90	90	90	—	IS 1448 (Part 56) / ASTM D2270
iii)	Pour Point[1], °C, *Max*	-33	-33	-27	-24	-21	-15	-9	-6	-6	-6	6	—	IS 1448 (Part 10) / ASTM D97
iv)	Flash Point[2], °C, *Min*	160	160	190	190	200	200	200	215	215	220	220	200 or 185	IS 1448 (Part 69) / IS 1448 (Part 21) / ASTM D92
v)	Evaporative loss, percent, *Max*	20	20	20	15	15	15	15	10	10	10	10	22 or 20[3]	IS 1448 (Part 136) / ASTM D5800
vi)	Foaming tendency[4] foaming/settling, ml/ml, *Max*													IS 1448 (Part 67) / ASTM D892
	a) at 24 °C	25 / Nil												
	b) at 93.5 °C	150 / Nil												
	c) at 24 °C after test at 93.5 °C	25 / Nil												

NOTES

[1] For defence requirement pour point for SAE 30 and SAE 40 shall be –18 °C, *Max* and for SAE 50 shall be –9 °C, *Max*.

[2] Flash point for multigrade is valid only for 0W-20, 5W-20, 5W-30, 10W-30 and for other multigrades it is not required.

[3] Evaporation loss for SAE 0W-20, 5W-20, 5W-30, 10W-30 is 22 and for SAE 15W-40 it is 20.

[4] For EPL 4 category the foaming tendency requirement shall be 10/0, 50/0, 10/0 (P-67) and 200/50 for high temp foaming tendency (ASTM D6082).

[5] The above table is reference purpose only and applicable for older grades. However, bench test requirements of EPL5 to EPL8 and EDL8 to EDL12 grades as per respective table shall be followed.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No./ International Standards	*Title*
IS 1447 (Part 1) : 2021	Methods of sampling of petroleum and its products Part 1 Manual sampling (*second revision*)

IS 1448	Methods of test for petroleum and its products
(Part 1/ sec 2) : 2002	Determination of base number of petroleum products by Potentiometric titration (*second revision*)
(Part 4/sec 2) : 2021	Part 4/Section 2 Ash from Grease, Sulphated Ash and Water Soluble Ash (*fourth revision*)
(Part 10/sec2) : 2021 / ISO 3016 : 2019	Petroleum and Related Products from Natural or Synthetic Sources Section 2 Determination of pour point (*third revision*)
(Part 16) : 2014 / ISO 3675 : 1998	Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method (*fourth revision*)
(Part 21) : 2019 / ISO 2719 : 2016	Determination of Flash Point — Pensky-Martens Closed Cup Method (*third revision*)
(Part 25/Sec 1) : 2018 / ISO 3104 : 1994	Transparent and opaque liquids Section 1 Determination of kinematic viscosity and calculation of dynamic viscosity (*second revision*)
(Part 33) : 2021	Sulphur by high pressure decomposition device method (*second revision*)
(Part 54) : 2017	Determination of Phosphorus Content — Quinoline Phosphomolybdate Method (*third revision*)
(Part 56) : 2013 / ISO 2909 : 2002	Calculation of Viscosity Index from Kinematic Viscosity (*third revision*)
(Part 67) : 2020	Determination of foaming characteristics of lubricating oils (*second revision*)
(Part 69) : 2019 / ISO 2592:2017	Determination of flash and fire points — Cleveland open cup method (*second revision*)
(Part 86) : 2023	Determination of total base number by potentiometrical perchloric acid titration method (*first revision*)
(Part 136) : 1991	Determination of evaporation loss of lubricating oils (Noack's method)
(Part187) : 2021/ ISO 3987 : 2010	Petroleum Products — Determination of Sulfated Ash in Lubricating Oils and Additives
ASTM D92-18	Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97-17B	Standard Test Method for Pour Point of Petroleum Products
ASTM D130-19	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D664-24	Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration
ASTM D874-23	Standard Test Method for Sulfated Ash from Lubricating Oils and Additives
ASTM D892-23	Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D2270-24	Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 °C and 100 °C
ASTM D2622-24	Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry
ASTM D2896-21	Standard Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration
ASTM D4052-22	Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
ASTM D4485-24	Standard Specification for Performance of Active API Service Category Engine Oils
ASTM D4629-24	Standard Test Method for Trace Nitrogen in Liquid Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection
ASTM D4683-20	Standard Test Method for Measuring Viscosity of New and Used Engine Oils at High Shear Rate and High Temperature by Tapered Bearing Simulator Viscometer at 150 °C

ASTM D4684-20A	Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature
ASTM D4711-89	Standard Test Method for Sulfonic and Sulfuric Acids in Alkylbenzene Sulfonic Acids
ASTM D4739-23	Standard Test Method for Base Number Determination by Potentiometric Hydrochloric Acid Titration
ASTM D4864-90	Standard Test Method for Determination of Traces of Methanol in Propylene Concentrates by Gas Chromatography
ASTM D4951-14	Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry
ASTM D5133 - 20A	Standard Test Method for Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature-Scanning Technique
ASTM D5185-18	Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
ASTM D5291-21	Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants
ASTM D5293-20	Standard Test Method for Apparent Viscosity of Engine Oils and Base Stocks Between –10 °C and –35 °C Using Cold-Cranking Simulator
ASTM D5302-00A	Standard Test Method for Evaluation of Automotive Engine Oils for Inhibition of Deposit Formation and Wear in a Spark-Ignition Internal Combustion Engine Fueled with Gasoline and Operated Under Low-Temperature, Light-Duty Conditions
ASTM D5762-24	Standard Test Method for Nitrogen in Liquid Hydrocarbons, Petroleum and Petroleum Products by Boat-Inlet Chemiluminescence
ASTM D5800-21	Standard Test Method for Evaporation Loss of Lubricating Oils by the Noack Method
ASTM D5966-22	Standard Test Method for Evaluation of Engine Oils for Roller Follower Wear in Light-Duty Diesel Engine
ASTM D5967-21	Standard Test Method for Evaluation of Diesel Engine Oils in T-8 Diesel
ASTM D5968-24	Standard Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 121 °C
ASTM D6082-23	Standard Test Method for High Temperature Foaming Characteristics of Lubricating Oils
ASTM D6278-20A	Standard Test Method for Shear Stability of Polymer Containing Fluids Using a European Diesel Injector Apparatus
ASTM D6335-19	Standard Test Method for Determination of High Temperature Deposits by Thermo-Oxidation Engine Oil Simulation Test
ASTM D6443-24	Standard Test Method for Determination of Calcium, Chlorine, Copper, Magnesium, Phosphorus, Sulfur, and Zinc in Unused Lubricating Oils and Additives by Wavelength Dispersive X-ray Fluorescence Spectrometry (Mathematical Correction Procedure)
ASTM D6557 - 18e1	Standard Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils

ASTM D6593-18e1	Standard Test Method for Evaluation of Automotive Engine Oils for Inhibition of Deposit Formation in a Spark-Ignition Internal Combustion Engine Fueled with Gasoline and Operated Under Low-Temperature, Light-Duty Conditions
ASTM D6594 - 20e1	Standard Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 135 °C
ASTM D6618-23	Standard Test Method for Evaluation of Engine Oils in Diesel Four-Stroke Cycle Supercharged 1M-PC Single Cylinder Oil Test Engine
ASTM D6681-23	Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1P Test Procedure
ASTM D6709-24	Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence VIII Spark-Ignition Engine (CLR Oil Test Engine)
ASTM D6750-23	Standard Test Methods for Evaluation of Engine Oils in a High-Speed, Single-Cylinder Diesel Engine—1K Procedure (0.4 % Fuel Sulfur) and 1N Procedure (0.04 % Fuel Sulfur)
ASTM D6922 - 13	Standard Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils
ASTM D6975-03	Standard Test Method for Cummins M11 EGR Test
ASTM D6984-18e1	Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIF, Spark-Ignition Engine
ASTM D6987/6987M-05	Standard Test Method for Evaluation of Diesel Engine Oils in T-10 Exhaust Gas Recirculation Diesel Engine
ASTM D7042 - 21a	Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)
ASTM D7097-19	Standard Test Method for Determination of Moderately High Temperature Piston Deposits by Thermo-Oxidation Engine Oil Simulation Test—TEOST MHT
ASTM D7216-22	Standard Test Method for Determining Automotive Engine Oil Compatibility with Typical Seal Elastomers
ASTM D7320-18e1	Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIG, Spark-Ignition Engine
ASTM D7422-23	Standard Test Method for Evaluation of Diesel Engine Oils in T-12 Exhaust Gas Recirculation Diesel Engine
ASTM D7468-22	Standard Test Method for Cummins ISM Test
ASTM D7528-22	Standard Test Method for Bench Oxidation of Engine Oils by ROBO Apparatus
ASTM D7549-24	Standard Test Method for Evaluation of Heavy-Duty Engine Oils under High Output Conditions—Caterpillar C13 Test Procedure
ASTM D7563-23	Standard Test Method for Evaluation of the Ability of Engine Oil to Emulsify Water and Simulated Ed85 Fuel
ASTM D7751 - 16	Standard Test Method for Determination of Additive Elements in Lubricating Oils by EDXRF Analysis
ASTM D8111-23A	Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIH, Spark-Ignition Engine
ASTM D8226-21ae1	Standard Test Method for Measurement of Effects of Automotive Engine Oils on Fuel Economy of Passenger Cars and Light-Duty Trucks in Sequence VIF Spark Ignition Engine
ASTM D8291-24	Standard Test Method for Evaluation of Performance of Automotive Engine Oils in the Mitigation of Low-Speed, Preignition in the Sequence IX Gasoline Turbocharged Direct-Injection, Spark-Ignition Engine
CEC L-36-A-90	The measurement of lubricants dynamic viscosity under high shear conditions (Ravenfield viscometer)
CEC-L-42-A-92	Heavy duty diesel piston deposits and cylinder bore polishing (OM 364A

	engine)
CEC-L-42-A-95	
CEC-L-52-T-97	Evaluation of diesel engine oils using the OM441LA diesel engine
CEC SG-L-099	
CEC SG-L-101	Evaluation of Performance of Heavy-Duty Engine Oils
SAE J300 (2021)	Engine Oil Viscosity Classification
SAE J2643 (2023)	Standard Reference Elastomers (SRE) for Characterizing the effect of liquids on Vulcanized Rubbers

ANNEX B
(*Clause* 4.3.1)
HOMOGENEITY TEST

B-1 GENERAL

This test determines whether oil is and will remain homogeneous and whether it will be miscible and be stable after being submitted to a prescribed cycle of temperature changes.

B-2 SAMPLE

B-2.1 Test Sample — Approximately 300 ml.

B-2.2 Standard Reference Oils — As approved by the qualifying authority.

B-3 APPARATUS

B-3.1 Test Jar

A test jar of clear glass, cylindrical form, flat bottom, approximately 30 mm to 35 mm in inside diameter and 115 mm to 125 mm in height.

B-3.2 Thermometers

- 50 °C to + 50 °C range.

B-3.3 Cork

To fit the test jar, bored centrally to put the test thermometer.

B-3.4 Jacket

Glass or metal, water-tight, of cylindrical form, flat bottom, about 115 mm in depth, with inside diameter 9.5 mm to 12.5 mm greater than the outside diameter of the jar.

B-3.5 Disk

Cork or felt, 6 mm in thickness, of the same diameter as the inside of the jacket.

B-3.6 Gasket

A ring gasket, about 5 mm in thickness, to fit snugly around the outside of test jar and loosely inside the jacket. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

B-3.7 Bath

A cooling bath of a type suitable for obtaining the required temperatures.

B-4 PROCEDURE

B-4.1 Shake oil sample well and pour into a sample jar to 75 mm mark. Add reference oil to each of the sample jars to the 75 mm mark. Mix the oil thoroughly and heat to 46 °C in a water-bath. After the oils reach room temperature, observe and record the colour and evidence of separation. Determine and record the pour point of each oil.

B-4.2 Maintain the temperature of the cooling bath at –1 °C to +2 °C. Support the jacket, containing the test jar, firmly in a vertical position in the cooling bath so that not more than 25 mm of the jacket projects out of the cooling medium.

B-4.3 Beginning at a temperature 12 °C before the expected pour point, at each test thermometer reading that is a multiple of 3 °C, remove the test jar from the jacket carefully and tilt it just enough to ascertain whether there is a movement of the oil in the test jar. The complete operation of removal and replacement shall require not more than 3 s. If the oil has not ceased to flow when its temperature has reached 10 °C, place the test jar in the jacket in a second bath maintained at a temperature of –18 °C to –15 °C. If the oil has not ceased to flow when its temperature has reached –7 °C, place the test jar in the jacket in a third bath maintained at a temperature of –34.5 °C. For determination of very low pour points, additional baths should be maintained with successively lower temperature differentials of about 17 °C. In each case transfer the test jar when the temperature of the oil reaches a point of 28 °C, above the temperature of the new bath. At no time place the cold/test jar directly in the cooling medium. As soon as the oil in the test jar does not flow when the jar is tilted, hold the test jar in a horizontal position for exactly 5 s, as noted by a stop-watch or other accurate timing device, and observe carefully. If the oil shows any movement under these conditions, place the test jar immediately in the jacket and repeat a test for flow at the next temperature 3 °C lower.

B-4.4 Continue the test in this manner until a point is reached at which the oil in the test jar shows no movement when the test jar is held in a horizontal position for exactly 5s. Certain lubricating oils tend to move as a whole and should be very closely observed. Record the reading of the test thermometer at this temperature, corrected for error, if necessary. Allow the samples to thaw; and when the cloudiness has barely disappeared, observe and record the colour and evidence of separation. When the samples reach room temperature, place them in an oil-bath after removing the thermometers. Heat the bath at 230 °C and immediately remove the sample jars. Cork the samples and store them at their respective pour points for 18 h to 24 h. Remove the jars and allow the samples to thaw. When cloudiness has barely disappeared, observe and record the colour and evidence of separation. Repeat the last operation when the samples reach room temperature.

B-5 METHODS OF REPORTING RESULTS

B-5.1 Report evidence of separation in the following four successive stages:

a) Initial sample;
b) Warmed to just above cloud point after having once reached pour point;
c) After a cycle of heating to 230 °C and cooling to pour point, storing it for 24 h at this temperature and warming to just above pour point; and
d) Warmed to room temperature.

B-5.2 Evidence of separation is to be reported as:

a) Condition:

i. Definite
ii. None or doubtful

b) Location:
i. Near top
ii. Near bottom
iii. Filament
iv. Uniformly distributed

c) Particle size:
i. Small, as in cloud or haze
ii. Specks or larger particles

d) Colour:
i. White or very light
ii. Yellow
iii. Black

ANNEX C
(*Clause* 5)
PROCEDURES FOR QUALIFICATION APPROVAL (FOR DEFENSE REQUIREMENTS ONLY)

C-1 PROCEDURE

C-1.1 The oil shall be qualified for use in defence forces in accordance with the provision of this standard. The authority for recommending a Qualification Approval is CQA(PP), Kanpur.

C-1.2 The CQA(PP), Kanpur will have following functions:

a) Approval for engine/performance test facilities of laboratories for the purpose of recognizing them to carry out engine/performance test evaluation as required by this standard.

b) Approval for blending and quality control facilities of lubricant manufactures for the purpose of ensuring their ability to manufacture qualified lubricants within the tolerance limits stipulated by this standard.

c) Scrutiny of laboratory test data including evaluation test components for the purpose of assessing whether the candidate lubricant formulation meet the requirements of the standard and accordingly recommend for or against qualifying the products.

C-1.3 Candidate oil companies desirous of obtaining the Qualification Approvals of their products for defence purpose shall apply to the CQA(PP) along with details in prescribed form which requires disclosure of full particulars of the formulation in terms of both base stocks and additive components along with the samples. Such application should be

addressed as confidential documents to the designated official of the CQA(PP), Kanpur. The information contained therein shall be treated in strict confidence and not disclosed to any person organizations, unless so authorized in writing by the candidate oil company.

The duly authenticated details required to be provided by the applicant firm to CQA (PP), Kanpur are as follows:

a) Finished product sample of 5 Litres in case of liquid lubricants submitted in a single container along with 2 litres of base Oil(s) and 50 g/ml to 250 g/ml (or as advised by CQAPP) each of all ingredients / additives being used in the manufacturing of the finished product.

b) The procedure for securing qualification of lubricating engine oils against this standard requires submission of the following information and documents by the applicant organization in specified formats to CQA (PP) Kanpur:

i. Type, viscosity grade and performance category of the standard against which approval is sought, including cross-labelling requirements, if any;
ii. Product identification code/brand name of the oil with viscosity grade(s);
iii. Conformance to composition, physico-chemical, other rheological, bench test and engine-performance data requirements as per Tables 1-15, as applicable;
iv. Product identification data as per Table 15; and
v. Any supplementary or alternate data or evidence in support of the performance claims.

c) It is possible that the performance test data would be generated on engine tests carried out in different laboratories conducted at different periods of time, using base stocks from different sources. It is also possible that certain test facilities referred in the standard may not be available. However, the applicant shall satisfy the CQA(PP) Qualification approval norms in terms of Base Oil Interchange (BOI), Viscosity Grade Read-Across (VGRA), Viscosity Modifier Interchange (VMI), minor additive component substitution etc. (as provided in the relevant API/ACEA/OEM specifications) and that the data presented is valid for the applicant's formulation in vogue. CQA (PP) based on the overall review of the performance data, shall decide whether the lubricating oil formulated by the applicant meets the requirements of this standard.

d) All the test results of the Quality Control and Assurance Test Parameters & percentage (percent) of various elements, including sulphur content, should be generated at their own laboratory and the copy of test report of laboratory, where Qualification/Type test have been carried out should be submitted to CQA(PP).

e) Infra-red spectra of the finished product; base oil(s) and all ingredients/additives are also to be submitted along with operating parameters.

f) The following documents also required to be submitted to CQA(PP) Kanpur

i. Formulation details of the product.
ii. Test Reports/Technical Details/Data sheets/specifications of all the materials used in the formulation.
iii. Traceability of procurement of base oils and all additives.

g) Certificate regarding homogeneity test of their products at least three different propositions with similar type of products of leading manufacturers such as M/s IOC, M/s BPCL, M/s HPCL, M/s Balmer Lawrie and Co. or any competitor oil are to be submitted.

h) Declaration of minimum shelf life of the product under consideration.

j) Storage stability data of full shelf life carried out at a time interval of six months. Copy of Initial and Final Test Report are also to be enclosed with storage stability Data.

k) In addition to above, firm shall submit engine/performance data or its supplementary supporting data/alternate data to demonstrate that their product meets the required performance level of governing specification

l) Complete list of laboratory equipments/testing facilities are to be submitted in the following format: -

Sr No	Name of test equipment & No/s	Test method	Make/ Model & Year of Purchase	Range	Sensitivity / least count	Purpose	Calibration status along with calibration certificate

m) The CQA(PP), Kanpur reserves the right to demand additional evidence/ test regarding the performance of the product & material used.

n) In case of any dispute, the decision of DGQA shall be final.

C-1.4 The CQA(PP) based on an overall review of the test data shall decide whether the candidate oil formulation meets the requirements of this standard.

C-1.5 In the event of the CQA(PP) recommending qualification approval, the CQA(PP) shall issue a qualification approval for the product meeting relevant details.

C-1.6 At any time, if there is a change in the base stock or base stock sources refining treatment or additives used in the formulation, requalification will be required. Where the proposed changes are minor, the CQA(PP) may at its discretion recommend waiving complete requalification or may require only partial requalification of the proposed changes.

C-1.7 In the event the candidate lubricant formulation is found to be marginally failing in some performance tests, the candidate oil company may disclose its formulation particulars to the CQA(PP) and request it to consider the possibility of a modified formulation meeting the requirements of this standard. In such event, the CQA(PP) may its discretion, suggest limited re-evaluation of the modified formulation. On the basis of such re-evaluation the CQA(PP) may consider recommending qualification approval to the modified formulation.

C-1.8 The oil once approved against the standard will be qualified for a period not exceeding 5 years from the date of the original qualification. When the qualification period has expired each product shall be requalified if the manufacturer wishes to maintain the formulation as a current product meeting this standard.

Table 15 Requirements for Finished Product Identification and Permissible Variation for Product-Conformance

[*Clause* C-1.3 (a) (iv)]

Sl No.	**Characteristics**	**Requirements**	**Method of Test**

(1)	(2)	(3)	(4)
i)	Density at 15 °C, g/ml	To be reported	IS 1448 (Part16) / ASTM D7042 / ASTM D4052
ii)	Flash point COC, °C, *Min*	As specified in Table 13	IS 1448 (Part 69) / ASTM D92
iii)	Pour point, °C, *Max*	As specified in Table 13	IS 1448 (Part 10) / ASTM D97
iv)	Kinematic viscosity, mm^2/s	Shall conform to the control viscosity as given in product PI and within viscosity range of the grade	IS 1448 (Part 25/Sec 1) / ASTM D445 / ASTM D7042
v)	Low temperature cranking viscosity, cP, *Max*	As specified in Table 1	ASTM D5293
vi)	Low temperature pumping, viscosity, cP, *Max*	As specified in Table 1	ASTM D4684
vii)	Viscosity index, *Min*	As specified in Table 13	IS 1448 (Part 56) / ASTM D2270
viii)	Foam tendency/stability	As specified in Table 13	IS 1448 (Part 67) / ASTM D892
ix)	Total base number	Up to 5: -0.5, *Min* Above 5: -10 percent, *Min*	IS 1448 (Part 86) / ASTM D2896 / ASTM D4739
x)	Total acid number	To be reported	IS 1448 (Part 1/Sec 1) / ASTM D664
xi)	Sulphur	± 20 percent of the reported value	ASTM D2622 / ASTM D4951 / ASTM D5185 / ASTM D7751 / ASTM D6443
xii)	Sulphated ash	± 20 percent of the reported value	IS 1448 (Part 4/Sec 2) / IS 1448 (Part 187) / ASTM D874
xiii)	Calcium	-10 percent to +20 percent of the reported value	ASTM D4951 / ASTM D5185 / ASTM D7751 / ASTM D6443
xiv)	Barium	-do-	-do-
xv)	Magnesium	-do-	-do-
xvi)	Zinc	-do-	-do-
xvii)	Phosphorus	-do-	ASTM D4951/ IS 1448 (Part 54)
xviii)	Nitrogen	-do-	ASTM D5762 / ASTM D4629 / ASTM D5291
xix)	Sodium	-do-	ASTM D4951

NOTE — Elements at Sl No. (xiii) to Sl No. (xix) to be reported subject to being present.