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ICS NO :

PAKISTAN STANDARD

INTERNAL COMBUSTION ENGINE LUBRICATING OIL (2ND REVISION)

PAKISTAN STANDARDS AND QUALITY CONTROL AUTHORITY,
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PAKISTAN STANDARD SPECIFICATION FOR INTERNAL COMBUSTION ENGINE LUBRICATING OIL (2ND REVISION)

0.0 FOREWORD

0.1 This Pakistan Standard was adopted by the Pakistan Standards and Quality Control Authority on - 11.02.2009 after the draft finalized by Petroleum and Allied Products Sectional Committee had been approved by the Chemical Divisional Council.

0.2 This specification covers the points of views of lube and lubricant manufacturers, oil additive supplier, consumers and oil technologist those have been discussed at length before taking into consideration. Furthermore, due weightage had to be given to the need for international coordination among standard prevailing in different countries of the world. The Committee also thanked Lubricant business society of Pakistan (LBSP) which represents almost all the stake holders in lubricant business that include national, multinational marketing companies & Independent lubricant blenders, Reclaimers and lube refinery for their proposal / recommendation & support data.

0.3 The second revision of Internal Combustion Engine Lubricating Oil was first published in 1963 (PS: 343 – 1963) and then first revised in 1981. The committee responsible for the preparation of this standard reviewed it and decided that the specification should deal with twenty three types of Engine Lubricating Oil in two groups and nine viscosity grades suitable for the crank case lubrication reciprocating Internal Combustion Engine of both spark ignition and the naturally aspirated compression ignition types.

0.4 It also refer to the specification of finished Lubricating oil issued by Ministry of Petroleum and Natural Resources (MOP&NR), Government of Pakistan vide their letter no PL-L (870) / 99 (spec) dated 3rd April 2003 and 21st October, 2003.

0.5 It also refers other international standard, prevailing in different countries of the world. Such as international lubricant standardization and approval committee (ILSAC), ACEA etc.

0.6 In orders to keep abreast with the advancement of additive technology and performance requirement of automotive industries. Pakistan Standards are revised periodically; or when deem necessary. Therefore suggestions from the members and all other stake holders in lubricant business are welcome and will be placed before the committee for future consideration.

2.0 SCOPE

2.1 This standard covers lubricating oils specification for Gasoline and Diesel engines used under a variety of operating conditions in passenger cars, Light & heavy duty trucks , tractors, vans , buses, power generation, industrial and construction equipments also for four stroke engine for motor cycle.

2.2 This specification covers twenty three (23) types of currently active American Petroleum Institute (API) performance categories in two (2) groups and nine (9) Society for Automotive Engineer (SAE) viscosity grades i.e. Mono grade without letter "W" i.e. SAE 30, 40 and 50 and six (6) multi grades with letter "W" i.e. SAE 10W30, 10W40, 15W40, 15W50, 20W40, 20W50 as per table -I. suitable for the crank case lubrication of reciprocating internal combustion engine of both spark ignition and compression ignition types.

2.3 The first group is designated "S" and includes group of engine oil intended primarily for use in gasoline powered engine such as passenger cars and light trucks etc. The "S" categories are SA, SB, SC, SD, SE, SF, SG, SH, SJ, SL, and SM as described in table 2 under "S" spark ignition (Gasoline) engine classification.

2.4 The second group is designated "C" and includes group of engine oil intended primarily for use in certain gasoline and diesel powered heavier vehicles etc. The categories under this group are CA, CB, CC, CD, CE, CF, CF-2, CF-4, CG-4, CH-4, and CI-4 as described in table II under "C" compression ignition (Diesel) engine classification.

2.5 The purpose of deciding whether the requirements 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 PS: 103 – 1991 " Method of Rounding of Numerical Value. " The number of signification places retained in the rounded off value should be the same as that of the specified value in this standard.

3.0 CLASSIFICATION

3.1 This standard includes SAE viscosity grade classification and API performance classification.

3.2 **SAE Viscosity Grade Classification:**

3.2.1 The SAE viscosity grades constitute a classification for engine lubricating oils in rheological terms only and are intended for use by engine manufacturers in determining the engine oil viscosity grades to be recommended for use in their engines and by oil marketers in formulating and labeling their products.

3.2.2 This Pakistan Standard established a system of viscosity classification for lubricating engine oil. This classification defines nine Society for Automotive Engineer (SAE) Kinematics viscosity grade (VG) in the rage of 9.3 mm^2/s to 21.9 mm^2/s at 100° C.

These nine kinematics viscosity grade are divided into two series i.e.

a. SAE Viscosity monograde

b. SAE Viscosity multigrade

3.2.3 This classification implies no quality evaluation and provide information only on the kinematics viscosity at the defining temperature of 100° C

3.2.4 Two series of viscosity grades are defined i.e. those contain the letter **W** and those that do not contain the letter **W.** Single – viscosity-grade oils (single-grades) with the letter **W** are defined by maximum low temperature cranking and pumping viscosities and a minimum kinematics viscosity at 100° C. Single grades without the letter **W** are based on a set of minimum and maximum kinematics viscosities at 100° C and a minimum high- temperature/ high-shear measured at 150° C and 1 million reciprocal seconds. Multiple-viscosity-grade oils (multi grades) are defined by all of the following criteria:

a. Maximum low-temperature cranking and pumping viscosities.

b. A kinematics viscosity at 100° C that falls within the prescribed range of one of the non- grade classifications.

c. A minimum high-temperature / high – shear viscosity at 150° C and I million reciprocal seconds.

3.3 **Performance Classification:**

API Performance classification for automotive engine oil are classified in two groups/Series that is "S" & "C" as defined in 2.3 and 2.4.

4.0 DEFINITIONS

4.1 **Fire point:**

The lowest temperature corrected to a pressure of 760mm Hg at which the vapour of sample is itself ignited and sustain burning for minimum of 5 second when the test flame is applied to **it,** under the specified condition of test (ASTM D-92).

4.2 **Flash point:**

The lowest temperature corrected to a pressure of 760 mm Hg at which the application of an ignition source cause the vapours above the surface of the sample to ignite momentarily under the specified condition of test (ASTM D-93)

4.3 **Pour point:**

The lowest temperature expressed as a multiple of 3^0C at which the sample is observed to flow when cooled, according to the prescribed conditions of this test (ASTM D-97).

4.4 **Lube Base oils (LBO)**

Hydrocarbon compounds (mineral oils) produced from a certain cut of petroleum/crude oil after its refining, separating fuel distillates and removing Aromate / asphalt, wax and other impurities. The base oils are used as a major ingredient in formulated lubricants

4.5 **Lubrication:**
The act of adding oils to reduce friction and wear between the moveable parts, to limit the increase in temperature caused by the friction and to remove residues resulting from internal combustion.

4.6 **Lubricity:**
A qualitative term describing the ability of a lubricant to minimize friction between and damages to surface in relative motion under load.

4.7 **Lubricating oil (Lubricant / Engine oil):**
A liquid lubricant, usually comprising of several ingredients including a major portion of lube base oil and miner portion of various additive to give them special properties that raise its quality and performance level.

4.8 **Strong (mineral) acid value:**
The quantity of base, expressed in number of milligrams of potassium hydroxide required to neutralize all the water soluble acidic components present in one gram of the sample.

4.9 **Total Base Number:**
The quantity of acid, expressed in terms equivalent number of milligram of potassium hydroxide per gram of sample, that in required to titrate a sample dissolved in specified solvent to a specified end point (ASTM D-2896).

4.10 **Viscosity index (VI):**
An integral number that indicates the effect of temperature change on oil viscosity. A high viscosity index indicates a relatively small change in viscosity with temperature change.

5.0 REQUIREMENTS:

5.1 ***General:*** The engine oil shall be petroleum product or a synthetically prepared product or a combination therefore, and may contain necessary product or a combination therefore, and may contain necessary additives to enable it to meet the requirements of the specification. It shall be free from suspended matter, sediments, water and other impurities. The additives shall be wholly dissolved or fully dispersed in the oil and shall remain uniformly distributed, at temperatures between pour point and 150^0C.

5.2 ***Homogeneity At Low Temperatures***: After being cooled to below pour point and then allowed to stand undisturbed for a period of 24 hours at a temperature of 6^0C above the appropriate maximum pour point given in table 1, the oil shall retain its homogeneity when examined visually.

5.3 ***Foaming Characteristics:*** There shall be no limits to the quantity of foam formed immediately after the end of any of the three five minutes blowing period and at the end of ten minutes setting periods the quantity of foam shall not exceed the prescribed values:
when tested in accordance with ASTM D – 892 or IP-146

Volume, ml. max.

a) Test at 24^0C 300
b) Test at 93.5^0C 25
c) Test at 24^0C after test at 93.5^0C 300

5.4 ***Grade Requirements***: The oil shall comply with the requirements given in table 1.

5.5 ***Oxidation and Bearing Corrosion Characteristics***: The oil shall be non.corrosive to alloy bearing and to ferrous and non- ferrous engine components. Satisfactory characteristics of the oil in this respect shall be demonstrated when tested according to the methods and test limits prescribed against each designation in table-3.

5.6 ***Detergency, Ring Sticking, Wear And Accumulation Of Deposits:*** The oil shall prevent the sticking of piston rings and clogging of oil channels and shall minimize the wear of the cylinders, rings and loaded engine components, such as the camshaft lobes, cam followers and valve rocker arms, rocker arms shafts and the oil pumps and the fuel injection pump gears,. The effectiveness of oil in this respect shall be demonstrated when tested according to the method and test limits prescribed against each designation in Table-3.

6.0 SAMPLING

6.1 Representative Samples shall be drawn and handled as prescribed in "ASTM" D-4057-2000" that is "Standard Practices for manual sampling of Petroleum and Petroleum Products".

6.2 **SAMPLE HANDLING PROCEDURE:**

6.2.1 The representative sample drawn as per above shall be divided in three parts/ containers/ sets and handled as follows.

6.2.2 Submit one of the container / set to the Authority and second set for analysis of the sample to the approved laboratory. The third set shall be handed over to the person / owner from whose possession, custody or control the sample is taken for his own reference or analytical use etc.

6.2.3 In case of quality dispute, the 1st set of sample retained with Authority shall be tasted for second report in the same or other approved laboratory (as agreed) in presence of the person, from whose possession the sample has been taken or his appointed representative to sign as witness of lab analysis. All other authorized personnel shall also attend & witness lab analyses. The result of second report shall be treated as final. However, the result shall be technically valid i.e. the test result falls with in the standard deviation and / or repeatability reproducibility limits of the reference test method otherwise a repeat testing should be carried out to ascertain the repeatability limits precision for rejection or acceptance of result.

In the mean time the person / owner. Who posses the third set of sample may choose to get this sample tested in an approved laboratory on his own for his satisfaction and technical support in case of any differences of opinion.

7.0 TEST PROCEDURE:

7.1 The requirement listed in this specification shall be determine in accordance with those standard test method mentioned against each spec. parameter in table 1.

7.1.1 Only those method shall be considered as refree method i.e. the test result / value obtained by these method shall be acceptable for settling the quality issue (conformance/ non conformance).

7.2 Precision and Interpretation of result.

7.2.1 The majority of Test method mentioned in table I contain a statement of precision (repeatability and reproducibility) to be expected from it. Attention is drawn to ASTM D-3244 "Standard Practice for UTILIZATION OF TEST DATA to DETERMINE CONFORMANCE WITH SPECIFICATION" which covers the use of precision data in the interpretation of test result; this procedure shall be used in case of dispute.

8.0 PACKING AND MARKING:

8.1 **PACKING:** The design, material of construction and condition of the drums or smaller container and the bulk tankers into which oil is packed shall be such as not to be detrimental to the quality of oil during normal transport and storage.

8.2 **MARKING:** The following information shall appear in legible and indelible marking on each drum and each small container, and in the case of oil supplied in bulk tankers, in the consignment documents pertaining to each tanker:

a) Manufacturer's name and complete address
b) Brand Name / Recognized trade-mark
c) API performance classification & SAE viscosity grade
d) Quantity of the material
e) Date of Manufacturing / Blend and shelf life/Batch No.
f) Should clearly indicate (%) percentage of Reclaimed base oil in the product.

9.0 ENGINE SERVICE CLASSIFICATION & PERFORMANCE:

9.1 Engine Oil Classification system was set up as a joint effort by API, ASTM and SAE. The letter classification system is a method to classifying engine oils according to their performance characteristics, and relating this to their intended type of service as described in Table -2 and Table-3 respectively.

9.2 The API system currently includes service classification for service station/ spark ignition engines ('S' Series), and for commercial applications/compression ignition/Diesel engines ('C' Series), it is an "open ended" system which allows for the addition of new designations with little change to existing ones.

9.3 The API decided to move directly from API service Classification SH TO SJ in order to avoid confusion with the abbreviation SI which is used for the system international d' unites (International system for units) and "Spark Ignition".

Table -1
Specification for Automotive Engine Lubricating Oil

TEST SCRIPTION	SAEMONO GRADE			SAE MULTI GRADE						TEST METHOD (Latest Edition)
	30	40	50	10w30	10w40	15w40	15w50	20w40	20w50	
Flash Point, Min ^{0}C	201	201	201	177	177	201	201	201	201	ASTM – D,92
Kinematic viscosity At 100 ^{0}C mm^2 / s (cst) Min Max	9.3 12.5	12.5 16.3	16.3 21.3	9.3 12.5	9.3 16.3	12.5 16.3	16.3 21.9	12.5 16.3	16.3 21.9	ASTM – D, 445
Low Temperature Viscosity at ^{0}C, CP Max	-	-	-	7000 at-25	7000 At-25	7000 at-20	7000 at-20	9500 at-15	9500 at-15	ASTM –D,5293
Pour Point ^{0}C Max	-6	-6	-6	-18	-18	-18	-18	-18	-18	ASTM – D,97
Visocity Index, Min.	90	90	90	120 Note 1	120 Note 1	120 Note 1	120 Note 1	120 Note 1	120 Note 1	ASTM –D,2270
Copper Strip corrosion 3 hrs at 100 ^{0}C, Max	1	1	1	1	1	1	1	1	1	ASTM – D,130
Metal Content / Sulfated Ash	a	a	a	a	a	a	a	a	a	AAS/ICP/XRF ASTM - D,874
Total Base Number Note 2	b	b	b	b	b	b	b	b	b	ASTM - D,2896

Note 1: If the product conforms to the low temperature viscosity requirements, a lower VI may also be acceptable.

Note 2: Applicable to API CD & above for Diesel Engine Oil and API SF & above for Gasoline and / or CNG Fuel Engine Oil.

Note a & b: To report – obtained test value as per specified test method.

Table-2
"S" Service Station / Spark ignition (Gasoline) Engine Classification

Designation & Its Description

"SM" for 2004 Gasoline Engine Warranty Maintenance Service (Current)
For all automotive engines currently is use. Introduced November 30, 2004 SM oils are designated to provide improved oxidation resistance, improved deposit protection, better wear protection, and better low-temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and *I* or qualify as Energy Conserving.

SL for 2001 **Gasoline Engine Warranty Maintenance Service (Current)**
For all automotive engines presently in use. Introduced July 1, 2001. SL Oils are designed to provide high-temperature deposit control and lower oil consumption. Some of these oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving.

SJ for 1996 Gasoline Engine Warranty Maintenance Service (Current)
Service typical of Gasoline engines in current and earlier passenger car, van and light truck operation under vehicle manufacturer's recommended maintenance procedures. First available from 15 October, 1996, oils of this category exceeded the minimum performance requirements of API service Category. SH with a slightly different simulated

distillation and evaporation loss, plus met the requirements of bench tests for wet filterability, gelatin index, high temperature deposits. API Service Category SJ also introduced a limit on phosphorus content of 0.10 mass % API Service Category SJ may be used where API SH and earlier categories have been recommended.

SH for 1994 Gasoline Engine Warranty Maintenance Service
Service typical of gasoline engines in current and earlier passenger car, van and light truck operation under vehicle manufacturers' recommended maintenance procedures. First available 1 January, 1994, oil in this category exceed the minimum performance requirements of API Service Category SG in the areas of deposit control, oil oxidation, wear rust and corrosion. Engine oils meeting API Service Category SH have been tested in accordance with the car manufacturer's Association (CMA) Code of Practice, and may be used where API Service Category SG and earlier categories have been recommended.

SG for 1989 Gasoline Engine Warranty Maintenance Service
Service typical of gasoline engines in passenger car, van and light-duty trucks, and some diesel engines, beginning with 1989 model operating under manufacturers' recommend maintenance procedures. Oils developed for API Service Classification SG provided improved control of sludge and vanish, oil oxidation and engine wear relative to engine oils developed for previous categories. These oils provide additional protection against rust and corrosion. Oils meeting API Service Category SG may be used when API Service Category SF, and earlier categories have been recommended.

SF for 1980 Gasoline Engine Warranty Maintenance Service
Service typical of gasoline engine in passenger cars and some trucks beginning with 1980 model operating under manufacturers' recommended maintenance procedures. Oils developed for this service provided increased oxidation stability and improved antiwear performance relative to engine oils that met the minimum requirements for API Service Category SE. These oils also provided protection against engine deposits, rust and corrosion. Oils meeting API Service Category SF may be used when API Service Categories SE, SD or SC are recommended.

SE for 1972 Gasoline Warranty Maintenance Service
Service typical of gasoline engines in passenger cars and some trucks beginning with 1972 and certain 1971 models operating under manufacturers' recommended maintenance procedures. Oils designed for this service provided more protection against oil oxidation, high-temperature engine deposits, rust and corrosion in gasoline engines than oil that satisfied API Engine Service Categories SD or SC and may be used when either of these categories is recommended.

SD for 1968 Gasoline Engine Warranty Maintenance Service
Service typical of gasoline engines beginning with 1968 models, Of little relevance to modern gasoline engines. Superseded by API Service Category SE in 1972. Oils of API Service Category SD should not used in any engine unless specifically recommended by the manufacturer.

SC for 1964 Gasoline Engine Warranty Maintenance Service
Service typical of gasoline engine in 1964 through 1967. Of little relevance to modern gasoline engines. Superseded API Service Category SD in 1968. Oils of API Service Category SC should not used in any engine unless specifically recommended by the manufacturer.

SB for Minimum-Duty Gasoline Engine Service
Oils meeting this service provided only mild antiscuff capability, and some resistance to oil oxidation and bearing corrosion. Oils of API Service Category SB should not used in any engine unless specifically recommended by the manufacturer.

SA formerly for Utility Gasoline and Diesel Engine Service
Oils for such mild service that the category had no performance requirements. Oils of API Service category SA should not be used in any engine unless specifically recommended by the manufacturer.

"C" COMMERCIAL / COMPRESSOR IGNITION (DIESEL) ENGINE

DESIGNATION & ITS DESCRIPTION

CI-4 for 2002 severe — Duty Diesel Engine Service
API CI-4 performance requirements describe oil for use in those high speed four-stroke diesel engines designed to meet 2004 exhaust emission standards, to be implemented from October 2002. These oils are recommended for use in all applications with diesel fuels ranging in sulfur content up to 0.05 by weight. These oils are especially effective at sustaining engine durability where Exhaust Gas Re-circulation (EGR) or other exhaust emission componentary may be used. Optimum protection despite control, valve-train wear, oxidative thickening foaming and viscosity loss due to shear. API CI-4 oils are superior to API Chl-4 and earlier categories and may be effectively use where there earlier categories grades are recommended.

CH-4 for 1998 Severe — Duty, Four Stroke Diesel Engine Service
API service category CH-4 are suitable for high speed, four stroke diesel engines designed to meet 1998 exhaust emission standards and are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. API CH-4 oils one superior in performance to those meeting API CG-4 and API CF4, and can be used where these are recommended.

CG-4 for 1994 Severe-Duty, Four-Stroke-Cycle Diesel Engine Service
API Service Category CG-4 describes oils for use in high speed, four-stroke-cycle diesel engines used in both heavy-duty, on highway and off-highway applications. CG-4 oils provide effective control over high temperature piston control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulating. These oils are especially effective in engines designed to meet 1994 U.S.A. exhaust emission standards and may also be used in engines requiring API Service Categories CF-4, CE and CD.

CF-4 for 1990 Sever-Duty, Four-Stroke-Cycle Diesel Engine Service
Service typical of certain high-speed, turbocharged and supercharged, four-stroke-cycle diesel engines since 1990. API Service Category CF-4 oils exceed the requirements of the API Service Category CE, and provide improved control of oil consumption and engine deposits. Oil meeting API Service Category CF-4 may be used when API Service Categories CE and CD are recommended for diesel engines.

CF-2 for 1994 Two-Stroke-Cycle Diesel Engine Service
API Service Category CF-2 denotes service typical of two-stroke-cycle engines requiring highly effective control over cylinder and ring-face scuffing and deposits. Oils designated for this service in may also be used when API service category CD-Il is recommended. These oils do not necessarily meet the requirements of CF or CF-4 unless passing test requirements of these categories.

CF for 1994 Indirect-Injected Diesel Engine Service
API Service Category CF denotes service typical of indirect-injected diesel engines, and other diesel engines which use a broad range of fuel types. Effective control of piston deposits, wear and copper-containing bearing corrosion is essential for these engines which may be naturally aspirated, turbocharged or supercharged. Oils designated for this service may also be used when API Service Category CD is recommended.

CE for 1983 Diesel Engine Service
Service typical of certain turbocharged and Supercharged heavy-duty diesel engines manufactured since 1983 and operating under high-load conditions for both low high speed operations. Oils designed for this service may be used where API Service Category CD is recommended for diesel engines.

CD-Il for 1983 Sever-Duty Two-Stroke-Cycle Diesel Engine Service
Service typical of two-stroke-cycle diesel engines requiring highly effective control over wear and deposits. Oils designed for this service also meet all the requirements of API Service Category CD.

CD for Diesel Engine Service
Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines where highly effective control of wear and deposits is vital or when using fuels of a wide quality range, including high-sulfur fuels. Oils designed for this service were introduced in 1965 and provide protection from bearing corrosion and from high-temperature deposits in these diesel engines.

CC for Diesel Engine Service
Service typical of certain naturally aspirated and lightly supercharged diesel engines operated in moderate to severe service, and certain heavy-duty gasoline engines. Oils designed for this service provided protection from bearing corrosion in these diesel engines, and from rust, corrosion and low-temperature deposits in gasoline engines. These oils were introduced in 1961.

CB for Diesel Engine Service
Service typical of diesel engines operated in mild to moderate duty. Oils designed for this service provided necessary protection from bearing corrosion and high-temperature deposits in normally-aspirated diesel engines with lower quality fuels. Oils of API service Category CB should not be used in any engine unless specifically recommended by the manufacturer.

CA for Diesel Engine Service
Service typical of diesel engines operated in mild to moderate duty with high-quality fuel. Oils designated for this service provided protection from bearing corrosion and from ring belt deposits in some naturally aspirated diesel engines when using such quality fuels that they imposed no unusual requirements for wear and deposits protection. Oils of API Service Category CA should not be used in any engine unless specifically recommended by the manufacturer.

TABLE 3

TEST TECHNIQUES AND PRIMARY PERFORMANCE CRITERIA

Letter Designation	Test Techniques	Primary Performance Criteria
SA	None	None

SB	L-4[e] or L-38[b]	Bearing weight loss, mg, max	L-4	L-38
	Sequence IV[e]	Cam scuffing Lifter scuff rating, max		None 2
SC	Sequence IIA[e]	Cam and lifter scuffing Avg cam plus lifter wear, in (min) max Avg rust rating, min Avg sludge rating, min Avg sludge rating min Avg varnish rating, min		None 0.0025 (0.064) 8.2 9.5 9.7
	Sequence IV[e]	Cam scuffing Lifter scuff rating, max		None 2
	Sequence V[e]	Total engine sludge rating, min Avg piston skirt varnish rating, min Total engine varnish rating, min Avg intake valve tip wear,in (min), max Ring sticking Oil ring clogging, % max Oil screen plugging, % max		40 7.0 35 0.0020(0.051) None 20 20
	L-38[c] L-I(0.95% min sulfer fuel)[e]	Bearing weight loss, mg, max Groove No 1 (top) carbon fill, % vol, max Groove No 2 and below		50 25 Essentially Clean
SD	Sequence IIB[e] and IIIB[e]	Cam and lifter scuffing Avg cam plus lifter wear, in (mm) max Avg rust rating , min Avg sludge rating, min Avg varnish rating, min		None 0.0030 (0.076) 8.8 9.6 9.6
	Sequence IV[e]	Cam scuffing Lifer scuff rating, max		None 1
	Sequence V.B[e]	Total engine sludge rating, min Avg piston skirt varnish rating, min Total engine varnish rating, min Avg intake valve tip wear, in (mm) max Oil ring clogging, % max Oil screen plugging, T, max		42.5 8.0 37.5 0.0015 (0.038) 5 5
	L38[c] L-1 (0.95%	Bearing weight loss, mg max Groove No 1 (top) carbon fill, % vol, max Groove No 2 lacquar coverage, % area max Groove No 2 and below Land No 3 and below		

	Falcon [c-e]	Avg engine rust rating, min		9.0	
	Sequence IIB[e], IIC[e],or IID	Avg engine rust rating, min Number stuck lifters	IIB 8.9 None	IIC 8.4 None	IID 8.5 None
SE	Sequence IIIC[e] or IIID	Viscosity increase at 100 F (37.78 C) and 40 test h, % max Viscosity increase at 40 °C and 40 test h, %, max Avg engine rating at 46 test h Avg piston skirt varnish rating, min (CRC manual No 9) Avg oil ring deposit rating, min (CRC manual No 9) Avg sludge rating, min CRC manual No 12 Ring sticking Lifter sticking Scuffing and wear at 64 test h Cam or lifter sciffing Camp plus lifter wear, in (mm) Average Maximum	111C 400 -- 		111D 400 375
	Sequence V-C	Avg engine studge rating min Crc manual No 12 Avg piston skirt varnish rating, min Crc manual no 9 Avg engine varnish rating, min Oil ring clogging, T, max Compression ring sticking			
SF	L-38	Bearing weight loss, mg, max			
	Sequence II D	Average engine Rust, min Lifter Sticking max			
	Sequence III D	Average Piston Varnish, min Average Oil ring Land Deposits, min Average Engine Studge, min Viscosity increase @ 40 °C max at 64 hours Cam + Lifter Wear, inches max Maximum Average ring Sticking, max Lifter sticking, max Lifter Sticking max Cam or lifter Scuffing, max Oil consumption, quarts, max			
	Sequence V D	Average engine Sludge, min Average Engine Studge, min Average Piston Skirt Varnish min Cam Lobe Wear, mils, max, Maximum			
SH	D 5844 (a b) (sequence)	Average engine rust rating, (c) min Number stuck lifters Average grey Value, min Hours to 375 % Kinematic Viscosity Increase at 40 °C, min Average engine sludge rating (e) min Average Piston skirt varnish rating, (f) min Average oil ring land deposit rating (f) min Lifter sticking Scuffing and wear Cam or lifter scuffing Average Max Maximum, max Ring sticking (oil-related (g) Kinematic viscosity, % increase at 40oC, max			

		Average position skirt varnish rating, F min Weighted position deposit rating, J min Screened average cam-pus-lifer wear Um, Max Hot stuck rings Kinematic viscosity, %increase at 40oC, max Average piston skirt varnish rating, F min Weighted piston deposit rating, J min Screened average cam-pus-lifer wear Um, Max Hot stuck rings Kinematic viscosity, % increase at 40 oC, max Weighted piston deposit rating (m) min Cam-plus-lifter wear avg.µm, max Hot stuck rings Average engine sluge rating, (e) min Rocker arm cover sluge rating, (e) min Average piston skirt varnish rating, (f) min Oil ring clogging % Oil Screen clogging % (hot stuck) Compression ring sticking (hot stuck) Cam wear µm Average, max Maximum max Average cam wear, µm (o) Average engine sludge rating, (e) min Rocker arm cover sludge rating (e) min Average piston skirt varnish rating, (f) min Average engine varnish rating, (f) min Oil screen clogging % max Hot stuck compression rings Boaring weight loss, mg, max Shear stability Boaring weight loss mg, max Shear stability			

Bench Test and measured Parameter (effective January 1, 1992)	Viscosity Grade Performance Criteria		
	SAE 5W-30	SAE 10W-30	SAE 15W-40
Test Method D 5800 Volatility loss, % max (t)	25	20	18
Test Method D 2887 volatility loss at 371oC (700oF), % max(t)	20	17	15
Test Method D 6795 (EOFT), % flow reduction, max	50	50	n r (u)
Test Method D4951 or D 5158, phosphorus % mass, max	0.12	0.12	n r
Test Method D4951 or D 5185, phosphorus % mass, max (all viscosity grades) (un loss valid passing Test Method D 5320 result are obtained)	0.06	0.06	0.06
Test method D92 flash point, oC min (v)	200	20	215
Test Method D 93 flash point, oC,min (v)	185	190	200
Test Method D 892 foaming tendancy (Option aA)			
Sequence I, max foaming/setting (w)	10/0	10/0	10/0
Sequence II, max foaming/setting (w)	50/0	50/0	50/0
Sequence III, max, foaming/setting (w)	10/0	10/0	10/0
Test Method D 6082 (optional blending required)	report(x)	report(x)	report(x)
Test Method D6922 homogeneity and miscibility	(y)	(y)	(y)

SJ	D 5844(a b) (Sequence IID)	Average engine rust rating, (C) min	8.5
		Number s tuck lifters	none
		Average grey value, min	100
		Hours to 375% kinematic viscosity increase at 40°C, min	64
		Average engine sludgerating,/min	9.2
		Average piston skit varnish rating,/min	8.9
		Average oil ring land deposit rating, /min	3.5
		Lifter sticking	None
		Scuffing and wear	
		Cam or lifter scuffing	None
		Cam plus lifter wear, µm	
		Average, max	30
		Maximum max	64
	Or D 6984 (Sequence IIF) (d)	Ring sticking (oil-related)(g)	None
		Kinematic viscosity, % increase at 40oC, max	325
		Average piston skirt varnish rating (f) min	8.5
		Weighted piston deposit rating, /min	3.5
		Screened average cam-plus-lifter wear, µm, max	20 (1.k)
		Hot stuck ring	None
	Or Sequence IIIG/	Kinematic viscosity, % increase at 40 °C, max	150
		Weighted piston deposit rating, (a 1) min	3.5
		Cam-plus-lifter wear avg, µm, max	60
		Hot stuck rings	None
	D 5302 (b n) (Sequence VE)	Average engine sludge rating,(e) min	9.0
		Rocker arm cover sludge rating (e)min	7.0
		Average piston skirt varnish rating, (f) min	6.5
		Average engine varnish rating, (f) min	5.0
		Oil ring clogging %	Report
		Oil screen clogging, % max	20.0
		Compression ring sticking (hot stuck)	None
		Cam wear, µm	
		Average, max	127
		Maximum max	380
	Or D 6891 (Sequence IVA) (n)	Average cam wear, µm (0)	120
	Plus, D 6593 (n) (Sequence VG)	Average engine sludge rating, (e) min	7.8
		Rocker arm cover sludge rating (e) min	8.0
		Average piston skirt varnish rating, (p) min	7.5
		Average engine varnish rating, (p) min	8.9
		Oil screen clogging, % max	20
		Hot stuck compression rings	None
	D 5119 (q) (L-38)	Bearing weight loss, mg, max	4c
		Shear stability	(r)
	Or D 6709 (q) Sequence VIII)	Bearing weight loss, mg, max	26.4
		Shear stability	(r)

Bench Test measured parameter	Viscosity Grade Parameter Criteria	
	SAE OW-20 SAE 5W-20 SAE 5W-30 SAE 10W-30	All Other
Test Method D 5800 volatility loss, % ma (z)	22	20 (aa)
Test Method D 6417 volatility loss at 371 oC (700 oF), % max (z)	17	15 (aa)
Test Method D 5480 volatility loss at 371 °C (700oF), % max (z)	17	15 (aa)
Test Method D 6795 (EOFT), % flow reduction, max	50	50
Test Method D 6794 (EOWTT), % flow reduction, max		
With 0.6 % H2O	report	report
With 1.0 % H2O	report	report
With 2.0 % H2O	report	report
With 3.0 % H2O	report	report
Test Method D 4951 or D 5185, phosphorus % mass, max	0.10 (a b)	nr (u)
Test Method D 4951 or D 5185, phosphorus % mass, min (unless valid passing Test Method D 5302 results are obtained)	0.06	
Test Method D 92 flash point, oC, min (v)	200	NR (u)

Test Method D 93 flash point, oC min (v)		185	NR (u)
Sequence I, max, foaming/setting (a. c)		10/0	10/0
Sequence II, max, foaming/setting (a,c)		50/0	50/0
Sequence III, max, foaming/setting (a,c)		10/0	10/0
Test Method D 6082 (optional blending required) Static foam, max, tendency/Stability		200/50 (a,d)	200/50 (a,d)
Test Method D 6922 homogeneity and miscibility		(y)	(y)
Test Method D 6335 High temperature deposits (TEOST 33), deposit Wt, mg, max		60	60
Bench Test measured Parameter		Viscosity Grade Performance Criteria	
		SAE OW-20	All Others
		SAE 5W-20	
		SAE 5W-30	
		SAE 10W-30	
Test method D5133 Gelation index, max		12	NR (u)
SL	Engine Test Method	Rate or Measured Parameter	Primary performance Criteria
	D 6984 (sequence IIIF)	Kinematic viscosity, % increase at 40oC, max	275
		Average pistion skirt varnish rating, (f) min	
		Weighted piston deposit rating, (j) min	
		Screened average cam-plus-lifter wear, um, max	
		Hot stuck Rings	
		Low temperature viscosity performance (a,e)	
	Or Sequence IIIG (1)	Kinematic viscosity % increase at 40 oC, max	
		Weighted piston deposit rating, (m), min	
		Cam-plus-lifter wear avg, um, max	
		Hot stuck rings	
		Low temperature viscosity performance (a f)	
		Cam wear average, um (u	
		Average engine sludge rating, (e) min	
		Rocker arm cover sludge rating, (e) min	
		Average piston skirt varnish rating, (f) min	
		Average engine varnish rating, (p) min	
		Oil screen clogging, % max	
		Hot stuck Compression rings	
		Cold stuck rings	
		Oil screen debris, %	
		Oil ring clogging, %	
		Bearing weight loss, mg, max	
		Shear stability	

Bench Test and measured parameter	Performance criteria
Test method D 6557 (Bill Rust Test), average grey value, min	100
Test Method D 5800 volatility loss, % max	15
Test Method D 6417 volatility loss at 371 oC (700oF), % max	10
D 6795 (EOFT), % flow reduction, max	50
D 6794 (EOWTT), % flow reduction max	
With 0.6 % H2O	50
With 1.0 % H2O	50
With 2.0 % H2O	50
With 3.0 % H2O	50
Test Method D 4951 or D 5185, phosphorus % mass, Max (a h)	0.10 (a b)
Test Method D 4951 or D 5185, phosphorus % mass, Min	0.06
(Unless valid passing Test Method D 5302 result are obtained)	
Test Method D 892 foaming tendency (option a)	
Sequence I, max, foaming/ setting (a c)	10/0
Sequence II, max, foaming/setting (a c)	50/0
Sequence III, max, foaming/setting (a c)	10/0

Test Method D 6082 (optional blonding required) static foam max Tendency/stability	
Test Method D 6922 homogeneity and miscibility	
Test Method D 7079 high temperature deposits (TEOST MHT-4)	
Deposit wt, mg, max	
Test Method D 5133 (Gelation index), max (a h)	

a) Demonstrate passing performance in either Test Method D 5844 or D 6557
b) Monitoring of this test method was discontinued in June 20, 2001. Valid test result shall predate the end of the last calibration period for the test stand in which this test method was conducted.
c) CRC Rust Rating Manual No 7 available from coordinating Research Council 219 perimeter Centre Pkwy., Atlanta, GA 30346.
d) Demonstration passing performance in wither Test Method D 5533 or D 6984. However, an oil passing Test Method D 6984 containing less than 0.08% mass phosphorus in the form of ZDDP shall also pass the wear limits in Test Method D5302 (see also footnote (L)).
e) CRC Sludge rating Manual No 12. Available from Coordinating Research Council, 219 perimeter Centre Pkwy., Atlanta, GA 30346
f) CRC Sludge Rating Manual No 14. Available from Coordinating Research Council, 219 perimeter Centre Pkwy., Atlanta, GA 30346
g) An oil-related stuck ring occurs on a piston with an individual oil ring land deposit rating 2.6
h) Determine at 60 h
i) Determine at 80 h
j) Determine weighted piston deposits by rating the following piston areas and applying the corresponding weightings: under crown, 10 % second land, 15 % third land, 30 % piston skirt, 10 % first groove, 5 % second groobe, 10 % third groove, 20 % Use CRC Varnish Rating Manual No 14 for all ratings.
k) Calculate by eliminating the highest and lowest cam plus lifter wear result and t han calculating an average based on the remaining ten rating position.
l) For oils containing at least 0.06% mass phosphorus in the form of ZDDP, demonstrating performance in the sequence IIIG test obiates the need to also conduct Test Method D 5302 (sequence VE), which was previously required for oils with less than 0.08% mass phosphors.
m) Unlike the sequence IIF test, position skirt varnish rating is not required in the sequence IIG test.
n) Demonstration pass performance in Test Method D5302, or alternatively, in both test Method D 6891 and Test method D 6593.
o) Determine cam wear according to Test Method 6891, Seven wear measurements are made on each cam lobe and the seven measured values are added to obtain an individual cam lobe wear result. The overall cam wear value is the average of the twelve individual cam lobe wear result.
p) Determine cam the average engine varnish rating by averaging the position skirt, right rocker arm cover, and left rocker arm cover vanish ratings. Use the CRC varnish Rating Manual No 14 for all rating.
q) Demonstrate passing performance in either Test Method D 5119 or D 6709.
r) Ten hour stripped kinematics viscosity (oil shall remain in original viscosity grades).
s) Passing bench test performance is only required for SAE 5 W-30, SAE 10W-3 and SAE 15W-40 viscosity grades aas defined in SAE J300
t) Meet either Test method D 5800 or Test Method D 2887 volatility requirement.
u) NR stands for Not Required.
v) Meet either Test method D 92 or Test Method D 93 flash point requirement
w) Determine setting volume at 5 min
x) Report kinetic foam volume (ml) and collapse time's
y) Homogenous with SAE reference oils.
z) Meet the volatility requirement in either Test Method D 5800, D 5480 or D 6417
aa) Passing volatility loss only required for SA SA 15W-40 oils
ab) This is non critical specification as described in practice D 3244
ac) Determine setting volume, in mL, at 10 min
ad) Determine setting volume, in mL, a 1 min
ae) Evaluate the 80 h test sample by test Method D 4684 at the temperature indicated by the low temperature grade of oil as deermined on the 80 h sample by test Method D 5293.
af) Measure the viscosity of the EOT oil sample by Test Method D 4684, the measured viscosity shall meet the requirement of the original grade or the next higher grade. The EOT sample can be either from a sequence IIIG or a Sequence IIGA test. (A sequence IIGA test is identical to a sequence IIG test, except only low temperature viscosity performance is measured) Additional details are provided in the sequence IIG test method, in section 13.6.
ag) Not required for oils containing a minimum of 0.08% mass phosphorous in the form of ZDDP
ah) Requirement applies only to SAE OW-20, 5W-20, OW-30 and 10W-30 viscosity grades.
ai) For gelation temperature at or above the W grade pump ability temperature as defined in SAE J300

SM	Engine Test Requirements (a)	Viscosity Grade Performance Requirements (b)	
		SAE OW-20, SAE 5w-20	All other
		SAE OW-30, SAE 5w-30	
		SAE 10W-30	
	Sequence IIG	Pass	Pass
	Sequence IIIGA	Pass	n r (d)
	Sequence IV A (ASTM D 6891)	Pass	Pass
	Sequence VG (ASTM D 6593)	Pass	Pass
	Sequence VIII (ASTM D 6709)	Pass	Pass
	Bench Test and Measured Parameter (a)	Viscosity Grade Performance Requirements (b)	

		SAE OW-20, SAE 5w-20	All other
		SAE OW-30, SAE 5w-30	
		SAE 10W-30	
	ASTM D 6557 (Ball Rust Test) avg grey value, min	100	100
	ASTM D 5800 evaporation loss, 1 hour at 250 oC, % max (f)	15	15
	ASTM D 6417, simulated distillation at 371 oC % min	10	10
	ASTM D 6795, EOFT< % flow reduction, max	50	50
	ASTM D 6794, EOWTT, % flow reduction, max		
	With 0.6 % H2O	50	50
	With 1.0 % H2O	50	50
	With 2.0 % H2O	50	50
	With 3.0 % H2O	50	50
	ASTM D 4951, phosphorus % mass, max (f)	0.08 (g)	NR
	ASTM D 4951, phosphorus % mass, min (f)	0.06 (g)	0.06 (g)
	ASTM D 4951 or D 2622, sufer % mass, max (f)		
	SAE OW-20, OW-3, 5W-30	0.5 (g)	NR
	SAE 10W-30	0.7 (g)	NR
	ASTM D 892 (Option a), foaming tendency		
	Sequence I, max tendency/stability (h)	10/0	10/0
	Sequence II, max, tendency/stability (h)	50/0	50/0
	Sequence III, max mL, tendency/stability (h)	10/0	10/0
	ASTM D 892 (Option a), high – temperature foaming mL, max, tendency/stability (i)	100/0	100/0
	ASTM 6922, homogeneity and miscibility	J	J
	ASTM D 6709, (sequence VIII)shear stability	k	k
	ASTM D 7097 (TEOST MHT), high – temperature deposits, Deposit wt, mg, max (f)	35	45
	ASTM D 5133, gelation index, max	12(1)	NR

a) Tests are per ASTM requirements
b) All oils must meet the requirements of the most recent edition of SAE J300
c) The Pass limits fo the Sequence IIG, IIGA, IVA, VG and VIII are the engine sequence test limits published I the ILSAC GF-4 passenger Car
d) Engine Oil Minimum performance standard [Table q-4 in Technial Bulletin 2 to the 15th edition of API 1509 (issued May 2, 2004)

Note: The ILSAC GF-4 engine sequence limits are also shown in appendix X5

e) NR = Not required.
f) Calculating converstion specified in ASTM D 5800 are allowed.
g) For all viscosity grades: if CF-4, CG-4 and/or CI-4 categories Precede the "S" category and there is no API Certificatioin marks, the limits for phosphorus, sulfur, and the TEOST MHT do not apply. Note that these oils have been formulated primarily for diesel engine and may not provide all the performance requirements consistent with vehicle manufacturers" recommendation for gasoline-fueled engines.
h) This is no critical specification as described in ASTM D 3244.
i) After 10 minutes setting period.
j) Ater 1 minute setting period.
k) Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.

l) Ten-hour stripped kinematic viscosity at 100oC. Kinematic viscosity must remain in original viscosity grade.
m) To be evaluated from 5oC to temperature at which 40 000 cP is attained, or 2 Celsius degree below the appropriate MRVIP temperature (defined by SAE J300), whichever occurs first.

Letter Designation	Test Technique	Primary Performance Criteria[a]			
	Sequence VD	Average Oil Ring Clogging % max Oil Screen Clogging % max Compression Ring Sticking, max	1.0 10.0 7.5 None		
	L-4[B] or L-38[b]	Bearing weight loss, mg, max Piston skirt varnish rating, min	L-4 10-135 9.0		L-38 50 9.0
	L-1 (0.95% min Sulfer fuel)[e]	Groove No. 1 (top) carbon fill, % vol, max Groove No. 2 and below		25 Essentially clean	
	L-4[e] or L-38[b]	Same as CA			
	L-1 (0.95% min Sulfer fuel)[e]	Same as CA except Groove No 1 (top carbon fill, %, ol, max		30	
	L-38	Bearing weight loss, mg, max Piston skirt varnish rating, min		50 9.0	
	LTD[e] or modified LTD[b.e]	Piston skirt varnish rating, min Total engine varnish rating, min Total engine sludge rating, min Oil ring plugging, % max Oil ring plugging, %, max	Ltd 7.5 - 35 25 25		
	Sequence IIA[e] IIB [b.e] llC[e] or IID	Avg engine rust rating, min	IIA 5.2	IIB 8.2	IIC 7.6 IID 7.7
	IH[e] or 1H2	Groove No 1 (rop) carbon fil, % vol, max Groove No 2 lacquer coverage, % area, max Land No 3 and below Weighted total demerits, max	IH 30 50 Essential clean		IH2 45 - - 140
	ID	Groove No 1 (top) carbon fill, % vol, max Groove No 2 and below			
	IG[e] or IG2	Groove No 1 (top) carbon fill, % vol, max Land No 2 carbon and lacquer coverage % area, max Groove no 2 carbon and tacquer coverage % area, max Land No 3 below Weighted total demerits, max	IG 60 50 30 Essentially clean		IG2 80 - - -- 300
	L-38[c]	Bearing weight loss, mg, max Avg piston varnish rating, min		50 9.0	
	D6709 (Sequence Vii) T-6 Or D 6483 (T-9)(b) T-7 Or	Bearing weight loss, mg, max Merit rating, (a) min Top piston ring weight loss, (C) average Mg max Liner wear, um , max Average rate of Kinematic viscosity increase			

	D 5967 (T-AB) (b) D 5968 (CBT) (d)	during last 0.040 50 h, mm(2)/s at 100 °C/h, max Average rate of kinematic viscosity increase from 100 to 150 h, mm (2)/s at 100 oC/h, max Copper mg/kg (ppm), increase, max Lead, mg/kg (ppm) increase, max Copper strip rating, (e) max			
	D 6750 (1k)	A 1k test program (f) with a minimum of two test, Acceptable according o the limits shown in the colums, To the right, is required to demonstrate performance for This category. Weighted demerits (WDK), (g h) max Top groove fill (TGF), (g) % man Top land heavy carbon (TLHC), (g) % max Averaghe oil consumption, g/kw-h, (0-252), max Final Oil consumption, g/kw-h (228-252h) max Piston ring, and liner scuffing Number of test allowed Piston ring sticking			
	D 6618 (IM-PC) D 6709 (Sequence VIII)	Top groove fill (TGF), 9g)% max Weighted total demerits (WTD), (g) max Piston ring sticking Piston, ring and liner scuffing Bearing eight loss, mg, max	70 (j) 240(j) None None One-t Test 29.3	MTAC (j) Two-Test(k) 31.9	MTAC(j) Three-Test(k) 33.0
	D 6618 (1M-PC)	Weighted total demerts (WTD), (g) max Cylinder line scuffing area, % max Cylinder liner port plugging area, Average, % max Single cylinder, % max Pistion ring faces distress demerits No 1 (firre ring), max Average of No 2 and 3, max Bearing weight loss, mg, max			
			One-Test	Two-Test (m)	Three-Test (m)
		Weighted demerits (WDN) (g n) Top groove fill (TGF), (g) %, Max Top land heavy carbon (TLHC), (g) % max Oil consumption, g/k W-h, (0-252 h) max Piston, ring and liner scuffing Number of test allowed Piston ring sticking Viscosity increase at 3.8% soot, cSt, max Filter plugging, different pressure, kPa(psi), max Oil consumption, g/kW-h(lb/lb/bhp-h)max 60 h viscosity (at 40 °C) Increase from 10 min sample, % max Kinematic viscosity, % increase at 40 °C max Bearing eight loss, mg, max Usrd oil viscosity, cSt grater than SAE J300 lower limit for grade, min (o)	286.2 20 3 0.5 None None 11.5 138 (20) 0.304 (0.0005) 325 150 29.3 0.5	311.7	323.0
		Wear mils, max Um, max Foaming characteroristics	0.45 (11.4)		

		Foaming/settling, (p) mL, max			
		Sequence I	10/0		
		Sequence II	20/0		
		Sequence III	10/0		
		Aeration, voleum % max	10.0		
		Copper, mg/kg (ppm) increase, max	20		
		Lead, mg/kg (ppm) increase, max	60		
		Tin, mg/kg (ppm) increase, max	Report		
		Copper strip rating, (e) max	3		
			One test	Two test (r)	Three test (r)
	D 6681 (1P) (s)	Weighted demerits (WDP), max	350	378	390
		Top groove carbon (TGC), demerits, max	36	39	41
		Top land caron (TLC), demerits, max	40	46	49
		Average oil consumption, g/h (0-3360 h) max	12.4	12.4	12.4
		Final oil consumption, g/h (312-360 h) max	14.6	14.6	14.6
		Piston, ring, and liner scuffing	None	None	None
		Weighted demerits (WDK), % max	332	347	353
		Top groove fill (TGF), % max	24	27	29
		Top land heavy carbon (TLHC), % max	4	5	5
		Average oil consumption, g/k W-h (0-250 h), max	0.5	0.5	0.5
		Piston, ring, and liner scuffing	None	None	None
		Average liner Wear, normalized to 1.75 %	25.4	26.6	27.1
		soot, um max	120	136	144
		Average top Ring Weighte Loss, mg max (o)			
		EOT Used Oil Load Content Loss New Oil Lead			
		Content, mg/kg (ppm), max	25	32	36
		Average pin Wear, mils, max	0.30	0.30	0.36
		(µm, max)	(7.6)	(8.4)	(9.1)
		Rocker Pad Average Wt. Loss, normalized to 4.5 % soot mg, max	6.5	7.5	8.0
		Oil Filter Differential pressure at EOT< kPa max	79	93	100
		Average Engine Sludge, CRC merits at EOT, min	8.7	8.6	8.5
		Relative viscosity at 4.8 % Scoot by TGA max			
		Viscosity increase at 3.8 % Soot by TGA,	2.1	2.2	
		cSt max	11.5	12.5	
		60 h Viscosity at 40 oC, increase from 10			
		min sample, % max	2.95	295 (MTAC)	295 (MTAC)
		Kinematic viscosity, % 40 oC, increase at 40	150	(u)	(u)
		oC max		150 (MATC)	150 (MTAC)
		Aeration, volum, % max	8.0	8.0 (MTAC)	8.0 (MTAC)
		Used Oil Elemental Concentration		(u)	(u)
		Copper, mg/kg (ppm) increase, max	20		
		Lead, mg/kg (pmm) increase, max	120		
		Tin, mg/kg (ppm) increase	Report		
		Copper strip rating, (e) max	3		
		Foaming/settling, (p) mL, max			
		SequenceI	10/0		
		SequenceII	20/0		
		SequenceIII	10/0		
			SAE 10W-30	SAE 15w-40	
		% volatility loss at 250 oC max	20	18	
		% volatility loss ast 371 oC max	17	15	
		Kinematic Viscosity after shearing, cSt min	SAE XW-30	SAE XW-40	
			9.3	12.5	

Letter Designation	Test Technique	Primary Performance Criteria			
			One-test	Two-test(v)	Three test (v)
CI-4	D 6923	Weighted demerits (WDR) max Top groove carbon (TGC), demerits, max Top land carbon (TLC), demerits, max Initial oil consumption (IOC) (0.252 h), g/h, average Final oil consumption, (432-504 h), g/h, average, max Pistion, mring, and liner distress Ring sticking Merit rating, (v), min Average crossed Wt. loss, mg, max Average top ring wight loss, mg Oil filter different pressure At 250 h, kPa, max Average engine sldge, CRC merits at EOT min Relative viscosity at 4.8 % soot (w) Kinematic viscosity, % increase (at 40 oC) % increase, max Kinematic viscosity, % increase at 40 oC max weighted derimerits (WDK), max Top groove fill (TGF), % max Top land heavey carbon (TLHC), % max Average Oil consumption, g/k W-h, (0-252 h), max Piston, ring and liner scuffing Average pin wear, mils, max or (µm), max Aeration, volume % max	382 52 31 13.1 IOC + 1.8 none none 1000 20.0 Repot 275 7.8 1.8 275 150 332 24 4 0.5 none 0.30 (7.6) 8.0	396 57 35 13.1 IOC + 1.8 none none 1000 21.8 Report 320 7.6 1.9 275 (MTAC) 150 (MTAC) 347 27 5 0.5 none 0.33 (8.4) 8.0 (MTAC) (u)	402
	Cl-4 Bench Test	Measured Parameter	Primary Performance Criteria		
	High temperature/High shear (AA) D 4684 (MRV-TP-1)	Viscocity after shear, (z) min The following limites are applied to SAE Viscosity grades OW, 5W, 10W and 15W;; Viscosity of 75 h used oil sample from T-10 test (or T-10A (a b) test) tested at -20 oC, mPa-s, max If yield strees is detected, use modified D-4684 (a c) (external preheat), then m Pa-s, max And yield strees, Pa Evaporative loss at 250 oC, %, max Copper, mg/kg (ppm) increase, max Lead, mg/kg (ppm) increase, max Tin, mg/kg (ppm) increase Copper strip rating, (e) max Kinematic viscosity after shearing, cSt, min Foaming/setting, (p) mL, max SequenceI SequenceII SequenceIII		3.50 mPa-s	

a. Requires greater than zero morlls on all individidual tatings to RR: d02 1219

b. Test Method D 6483 and its limits can be use da an alternate for the T-6 test and its limits, Test method D 5967 9T-BA version) and its can be used as an alternater for the T-7 test and its limits.
c. Refer to RR: D 02 1273
d. Specification D 4485-94 Lists the NTC-400 9test Method D 5290) as a test method required to demonstrate performance for this category. Due to lack of availability of critical test parts the NTC-400 is no longer available, as calibrated test, and has been replaced in this category by the requirement for a second 1 K test and Test Method D 5968. Alternatively, instead of running a second 1K test and Test Method D 5968, data from NTC-400 tests, run in calibrated test stands, can be used to support this category in accordance with all the provisions of specification D 4485-94; see Annex A8 fro detailed description.
e. The rating system in test Method D 130 is used to rate the copper coupon in Test Methods D 5968 and D 6594
f. See Annex A2 for additional information
g. CRC Diesel engine Rating manual no 18 available from coordinating Research Council, 219 perimeter Center Pkwy, Atlanta, GA 30346
h. Refer to RR: D02-1273
i. If three or more operationally valid tests have been run, the majority of these tests not have scuffing. The scuffed tests are considered uninterpretable, and all data from these tests are eliminated from averaging.
j. See Annex A3 for additional information
k. See Annex A4 for additional information
l. See Annex A5 for additional information
m. See Annex A6 for additional information
n. Refer to RR: D02-1321
o. Limits do not apply to monograe oils
p. Ten minutes for sequence I, II and III
q. Refer to RR: D02-1379
r. See Annex A7 for additional information
s. Refer to RR: D02-1441
t. Refer to RR: D02-1439
u. See Annex A1: use method without transformations
v. See Annex A9 for additional information
w. Relative Voscosity (RV) = viscosity at 4.8% soot/viscosity of new oil sheared in Test Method D 6278
x. Refer to RR: D02-1441
y. Refer to RR: D02-1273. Alternatively, Test Method D 6750 (1N) can be used; if this Test Method is used, the measured parameter performance criteria are the same as those shown for Test Method D 6750 (1N) in the CG-4 category.
z. Nonrcritical specification as defined by Practice D 3244; may be superseded only byt application higher limits set by SAE J300
aa. Test as allowed in SAE J300
ab The T-10A test is the name given to a T-10 test run for 75 h to generate the sample for measurement by the Test Method D 4684
ac Refer to RR: D02-1517

References

In the preparation of this standard reference were made to the following

ASTM Standard

Annual Book of ASTM standard volume 05/sectuib 5 Petroleum products and Lubricants.

Visit ASTM website: www.astm.org

- ASTM D 92 -05a Standard Test method for Flash and Fire Points by Cleveland oOpen Cup
- ASTM D 97