Engine Oil Licensing and Certification System

API 1509
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AMERICAN PETROLEUM INSTITUTE

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Downstream Segment

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Foreword

This publication describes the voluntary API Engine Oil Licensing and Certification System (EOLCS) and is intended to explain to marketers how the API Engine Oil Quality Marks are licensed and displayed for the consumer. The publication describes methods for developing new engine oil performance standards and provides the marketer with a description of the API Marks and their use, licensing requirements, aftermarket conformance, and enforcement procedures. It also explains the interaction and roles of the various independent organizations that are part of the API EOLCS.

Suggested revisions are invited and should be submitted to the Standardization Director, American Petroleum Institute, 200 Massachusetts Ave., N.W., Washington, D.C. 20001, USA.

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Engine Oil Licensing and Certification System

1 Scope

This publication describes the API Engine Oil Licensing and Certification System (EOLCS), a voluntary licensing and certification program designed to define, certify, and monitor engine oil performance deemed necessary for satisfactory equipment life and performance by vehicle and engine manufacturers. Engine oil marketers that meet EOLCS requirements may be licensed to display two Marks, the API Service Symbol and the API Certification Mark.

Sections 2 through 8 of this publication define the current API engine oil service categories and explain the EOLCS licensing requirements, the API Marks and their use, and the EOLCS Aftermarket Audit Program (AMAP). Annexes A through T provide a brief history of engine oil classifications, describe methods for developing new engine oil performance requirements, and explain the interaction and roles of the various independent organizations that are part of the API EOLCS.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

American Chemistry Council Petroleum Additives Panel Product Approval Code of Practice

ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*

ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*

ASTM D445, *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)*

ASTM D892, *Standard Test Method for Foaming Characteristics of Lubricating Oils*

ASTM D1552, *Standard Test Method for Sulfur in Petroleum Products (High-Temperature Method)*

ASTM D2007, *Standard Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum Derived Oils by the Clay-Gel Absorption Chromatographic Method*

ASTM D2270, *Standard Practice for Calculating Viscosity Index From Kinematic Viscosity at 40 and 100°C*

ASTM D2622, *Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-Ray Fluorescence Spectrometry*

ASTM D2887, *Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography*

ASTM D3120, *Standard Test Method for Trace Quantities of Sulfur in Light Liquid Petroleum Hydrocarbons by Oxidative Microcoulometry*

ASTM D3244, *Standard Practice for Utilization of Test Data to Determine Conformance with Specifications*

ASTM D4294, *Standard Test Method for Sulfur in Petroleum and Petroleum Products by Energy-Dispersive X-Ray Fluorescence Spectroscopy*

ASTM D4485, *Standard Specification for Performance of Engine Oils*

ASTM D4683, *Standard Test Method for Measuring Viscosity at High Shear Rate and High Temperature by Tapered Bearing Simulator*

ASTM D4684, *Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature*

ASTM D4741, *Standard Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer*

ASTM D4927, *Standard Test Method for Elemental Analysis of Lubricant and Additive Components, Barium, Calcium, Phosphorus, Sulfur, and Zinc, by Wavelength-Dispersive X-Ray Fluorescence Spectroscopy*

ASTM D4951, *Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry*

ASTM D5119, *Standard Test Method for Evaluation of Automotive Engine Oils in CRC L-38 Spark Ignition Engine*

ASTM D5133, *Standard Test Method for Low Temperature, Low Shear Rate, Viscosity/Temperature Dependence of Lubricating Oils Using a Temperature-Scanning Technique*

ASTM D5185, *Standard Test Method for Determination of Additive Elements, Wear Metals, and Contaminants in Used Lubricating Oils and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)*

ASTM D5293, *Standard Test Method for Apparent Viscosity of Engine Oils Between –5 and –30˚C Using the Cold-Cranking Simulator*

ASTM D5302, *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 D5480, *Standard Test Method for Motor Oil Volatility by Gas Chromatography*

ASTM D5481, *Standard Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer*

ASTM D5533, *Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIE Spark Ignition Engine*

ASTM D5800, *Standard Test Method for Evaporation Loss of Lubricating Oils by the NOACK Method*

ASTM D5844, *Standard Test Method for Evaluation of Automotive Engine Oils for Inhibition of Rusting (Sequence IID)*

ASTM D6082, *Standard Test Method for High Temperature Foaming Characteristics of Lubricating Oils*

ASTM D6202, *Standard Test Method for Automotive Engine Oils on the Fuel Economy of Passenger Cars and Light-Duty Trucks in the Sequence VIA Spark Ignition Engine*

ASTM D6335, *Standard Test Method for Determination of High Temperature Deposits by Thermo-Oxidation Engine Oil Simulation Test*

ASTM D6417, *Standard Test Method for Estimation of Engine Oil Volatility by Capillary Gas Chromatography*

ASTM D6557, *Standard Test Method For Evaluation of Rust Preventative Characteristics of Automotive Engine Oils*

ASTM D6593, *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 D6616, *Standard Test Method for Measuring Viscosity at High Shear Rate by Tapered Bearing Simulator Viscometer at 100°C*

ASTM D6837, *Standard Test Method for Measurement of Effects of Automotive Engine Oils on Fuel Economy of Passenger Cars and Light-Duty Trucks in Sequence VIB Spark Ignition Engine*

ASTM D6794, *Standard Test Method for Measuring the Effect on Filterability of Engine Oils After Treatment with Various Amounts of Water and a Long (6-h) Heating Time*

ASTM D6795, *Standard Test Method for Measuring the Effect on Filterability of Engine Oils After Treatment with Water and Dry Ice and a Short (30-min) Heating Time*

ASTM D6891, *Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IVA Spark-Ignition Engine*

ASTM D6922, *Standard Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils*

ASTM D7097, *Standard Test Method for Determination of Moderately High Temperature Piston Deposits by Thermo-Oxidation Engine Oil Simulation Test-TEOST MHT*

ASTM D7320, *Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIG, Spark-Ignition Engine*

ASTM D8111, *Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIH, Spark-Ignition Engine*

ASTM D8114, *Standard Test Method for Measurement of Effects of Automotive Engine Oils on Fuel Economy of Passenger Cars and Light-Duty Trucks in Sequence VIE Spark Ignition Engine*

ASTM D8226, *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 RR:D02:1204, *Fuel Efficient Engine Oil Dynamometer Test Development Activities, Part II (Sequence VI Test)*

CEC L-36-A-90, *High Temperature/High Shear Viscosity*

CEC L-40-A-93, *Evaporative Loss of Lubricating Oils*

DOD CID A-A-52039A, *Lubricating Oil, Automotive Engine, API Service SG*

DOD MIL-L-2104, *Lubricating Oil, Internal Combustion Engine, Tactical Service*

GM 9099P, *Engine Oil Filterability Test (EOFT)*

GM 9099P, *Engine Oil Filterability Test (EOFT) (Modified), May 1980*

JPI 5S-41-93, *Evaporative Loss*

SAE J183, *Engine Oil Performance and Engine Service Classification (Other Than “Energy-Conserving”)*

SAE J300, *Engine Oil Viscosity Classification*

SAE J357, *Physical and Chemical Properties of Engine Oils*

SAE J1423, *Classification of Energy-Conserving Engine Oil for Passenger Cars, Vans, and Light-Duty Trucks*

3 Terms and Definitions

For the purposes of this document, the terms and definitions in Annex I apply.

4 EOLCS Overview

4.1 The API EOLCS is designed to define, certify, and monitor engine oil performance that vehicle and engine manufacturers and the oil and additive industries deem necessary for satisfactory equipment life and performance. The system includes a formal license agreement executed by the marketer with API. The program's Marks are intended to help the consumer identify products that have satisfied the requirements for licensing and certification. The system includes an audit process to verify that licensed products in the marketplace comply with the terms of the API Licensing Agreement.

4.2 API issues a license to an oil marketer after the marketer confirms it has met all the requirements spelled out in this publication and the EOLCS Online Application (http://engineoil.api.org). The marketer must execute the API Licensing Agreement as a condition of licensure.

Note: An oil marketer is defined as the marketing organization responsible for the integrity of the brand name and the representation of the branded product in the marketplace.

4.3 Performance requirements, test methods, and limits are cooperatively established by vehicle and/or engine manufacturers [namely, some or all of those represented by the Alliance of Automobile Manufacturers; Japan Automobile Manufacturers Association (JAMA); and Truck and Engine Manufacturers Association (EMA)], technical societies such as ASTM and SAE, and trade associations such as API and the American Chemistry Council (ACC).

4.4 API licenses two types of Marks: the API Service Symbol and the API Certification Mark. The Service Symbol denotes a licensed oil's performance properties through the API Service Categories; the SAE viscosity; and, if applicable, the Resource Conserving, ~~Energy Conserving,~~ CI-4 PLUS, and SN PLUS classifications. The API Certification Mark identifies oils meeting International Lubricant Specification Advisory Committee (ILSAC) minimum performance standards.

4.5 API uses an alphanumeric system known collectively as API Service Categories to define specific engine oil performance standards. These categories are commonly used by vehicle, engine, and equipment manufacturers to identify the engine oil performance standards required by gasoline and diesel engines. The API Service Symbol displays current API Service Categories. The process for developing API "C" categories is explained in Annex D.

The API Certification Mark does not change. Annual licenses for the API Certification Mark are issued only for engine oils that meet the current ILSAC performance requirements specified in Annex Q. The process for developing new engine oil performance standards for the API Certification Mark is explained in Annex C. At any time during this process, API's Lubricants Standards Group may ask ASTM or other bodies to recommend specifications for passenger car motor oils not addressed by the ILSAC minimum performance specification. This may include the API Lubricants Standards Group itself formulating a standard for a separate engine oil quality category based on deviations/exceptions from the specification being considered during the Annex C process. A Lubricants Standards Group passenger car motor oil standard would be designated as an API S Service Category.

4.6 Engine oils licensed to use the API Service Symbol and/or the API Certification Mark must be engine tested using the latest edition of the ACC Petroleum Additives Panel Product Approval Code of Practice (ACC Code). The ACC Code requires advance registration of all engine tests along with criteria for handling results from multiple tests on an oil formulation to improve the measurement of the oil's performance (see Annex N). Material updates to the ACC Code will be distributed to ILSAC, EMA, and API sufficiently in advance of formal publication to permit consideration of any comments the three stakeholders may have. Adherence to the ACC Code as a requirement for the API EOLCS will be periodically reviewed for continued suitability and enhancement.

4.7 The ACC Code currently includes only certain engine tests. For engine oils that use the API S and C Service Categories and/or the Resource Conserving, CI-4 PLUS, and SN PLUS classifications, the engine tests covered by the ACC Code shall be conducted in accordance with the ACC Code.

4.8 The ultimate assessment of an engine oil's performance includes a variety of vehicle fleet tests that simulate the full range of customer driving conditions. The engine sequence and bench tests listed in this document have been

specified instead of fleet testing to minimize testing time and costs. These specific tests were selected to mimic challenging field conditions and have been judged to be predictive of and applicable to a variety of vehicle tests under similar field conditions. The tests were vetted and agreed to in open forums operated under the auspices of organizations such as API, ASTM, and SAE. The relationships between engine sequence tests and vehicle fleet tests are judged valid based only on the range of base oils and additive technologies investigated — generally those that have proven to have satisfactory performance in service and that are in widespread use at this time. It is the responsibility of licensees introducing base oils or additive technologies that constitute a significant departure from existing practice to ensure that there is no adverse effect to vehicle components or to emission control systems by ensuring that sufficient supporting vehicle fleet testing data has been generated. This vehicle fleet testing should be conducted in addition to the other performance requirements listed in this specification. No marketer can claim to be acting in a reasonable and prudent manner if the marketer knowingly uses a new technology — defined as a significant departure from existing industry practice — based only on the results of engine sequence testing without verifying the suitability of the new technology in vehicle fleet testing that simulates a reasonable range of customer operation.

In addition to the requirements for API licensure, marketers should assess all products produced under API licenses using generally accepted quality control measures for adherence to the expected rheological properties submitted in the EOLCS Online Application, their products' specific elemental composition, and other category requirements that may indicate product compliance (Licensed Fingerprint) for such product prior to release for sale. Additionally, the API AMAP program will inspect lubricants in the marketplace for these same properties as further assurance of API license compliance.

Marketers are responsible for confirming that adding identification markers to an oil formulation does not impact that oil's performance. Such markers can include dyes, fragrances, isotopic markers, or any other chemical identifier.

4.9 The oil marketer of products claiming any API Service Category is responsible for ensuring the oil meets the API category requirements. In addition to the support data available in the ACC Candidate Data Package, the oil marketer shall have sufficient data to ensure that the inclusion of any nonperformance-related materials into the oil formulation such as for product identification maintains the performance of the oil to be licensed consistent with the licensable quality level being sought.

4.10 The test data that support product claims are the responsibility of the individual marketer. The API Lubricants Standards Group through its Base Oil Interchange (BOI)/Viscosity Grade Read Across (VGRA) Task Force develops Base Oil Interchange and SAE Viscosity-Grade Engine Testing Guidelines.

4.11 The API Lubricants Standards Group and BOI/VGRA Task Force will determine if additional testing is required per the matrix testing described in Annex C or Annex D for the new engine tests to ensure that sufficient data is available to allow the establishment of appropriate Base Oil Interchangeability and Viscosity-Grade Engine Testing Guidelines simultaneous with the establishment of the category performance criteria. Alternatively, companies may put forth engine test data supporting new read-across or interchange guidelines for adoption through balloting.

4.12 Marketers may choose to use the API Base Oil Interchangeability Guidelines, the API Guidelines for SAE Viscosity-Grade Engine Testing, or both in lieu of specified engine testing. However, the decision to use such guidelines does not absolve the marketer of the responsibility to ensure that each licensed engine oil satisfies all engine and bench testing performance requirements.

4.13 Previous sections notwithstanding, the oil marketer shall not interchange any base stock within a licensable formulation that could result in compromising the intended performance of that formulation against that license.

4.14 All engine oils licensed to use the API Marks are subject to conformance audits. Conformance is determined by comparing measured physical and chemical properties of the oil with licensing data on file at API. In addition, a limited number of products may be randomly selected for engine and bench testing.

4.15 An Administrative Guidance Panel (AGP) has been established in accordance with the terms of a Memorandum of Understanding between API and Ford, General Motors, and Chrysler for the purpose of providing guidance to the EOLCS. An Interindustry Advisory Group (IAG; see Annex B) consisting of representatives from organizations such as API, ASTM, ACC, EMA, Independent Lubricant Manufacturers Association (ILMA), Ford, General Motors, Chrysler, SAE, and the U.S. Army has been formed to advise the AGP on enhancements and improvements to the API EOLCS. Recommendations by the IAG will be considered for inclusion in the program.

5 Description of API Marks

5.1 General

5.1.1 API licenses two types of Marks: the API Certification Mark “Starburst” and the API Service Symbol “Donut.” On May 1, 2020, API will begin licensing a third mark, the API Certification Mark “Shield.” Certain oils are capable of meeting the technical and licensing requirements of two of the marks. If properly licensed, these engine oils may be labeled with either or two API Marks. Examples of these three types of Marks are shown in Figures 1 and 2.

5.1.2 API’s licensing of an engine oil does not imply that oils with the API Marks are appropriate for all vehicles or engines in the field. The consumer must refer to the owner’s or operator’s manual for specific vehicle or engine manufacturer’s engine oil recommendations.

5.2 API Certification Marks “Starburst” and “Shield”

5.2.1 Each API Certification Mark is designed for the identification of engine oils recommended for a general application (for example, gasoline, fuel-flexible, and light-duty diesel). The API Certification Marks Starburst and Shield may be licensed only if an oil satisfies the requirements of the most recent and applicable ILSAC minimum performance standards specified in Annex Q. The API Starburst remains the same for a given application even if a new minimum engine oil performance standard is developed for the application (see Annex C). The viscosity within the API Shield may be changed if new viscosities are added to the requirements in Annex Q, paragraph Q.6.

Figure 1—API Certification Marks Starburst and Shield

5.2.2 The ILSAC GF-5 minimum performance standard for passenger car motor oils (see Annex Q, paragraph Q.5) provides the current basis for issuance of a license to use the API Certification Mark. (See 5.4 for a list of viscosity grades eligible to obtain a license to use the API Certification Mark). On May 1, 2020, API-licensed oils that meet the criteria for ILSAC GF-6A will be eligible to display the API Starburst, and API-licensed oils that meet ILSAC GF-6B will be eligible to display the API Shield (see Annex Q, paragraph Q.6).

5.3 API Service Symbol

5.3.1 General

Service Categories are placed in the upper portion of the API Service Symbol to identify specific engine oil performance standards. The API Service Symbol may be licensed for use with passenger car motor oils, diesel engine oils, or both if the oils meet the performance standards of an appropriate API Service Category or Categories. Currently, the API Service Categories that may be included in the API Service Symbol are SN, SM, SL, SJ~~, SH (when preceded by a C category)~~, CH-4, CI-4, CJ-4, CK-4, and FA-4 (note that FA-4 cannot appear in the API Service Symbol with any C Service Category). On May 1, 2020, API SP may be included in the Service Symbol. Oils that meet API CI-4 licensing requirements are also authorized to display CH-4 in the API Service Symbol. Oils that meet API CJ-4 licensing requirements are also authorized to display CI-4 with CI-4 PLUS, CI-4, and CH-4 in the API Service Symbol. Oils that meet API CK-4 licensing requirements are also authorized to display CJ-4, CI-4 with CI-4 PLUS, CI-4, and CH-4 in the API Service Symbol. SAE 0W-16 and 5W-16 oils may only be licensed as API SN. Beginning May 1, 2020, SAE 0W-16 and 5W-16 oils may be licensed as API SP.

Figure 2—API Service Symbol

Note: The letters “SI”, “SK”, and “SO” (as of May 1, 2020) have been or will be omitted from the sequence of letter designators for API Service Categories because of their common association with other organizations or systems.

Use of more than one API S Service Category at a time in the API Service Symbol is prohibited. ~~Service Category SH can be displayed in the API Service Symbol only when preceded by CH-4 and/or CI-4, and/or CJ-4.~~ These alphanumeric Service Categories may change as new oil performance standards are developed and approved for use (see Annex D).

For an oil that is formulated for diesel engine applications and meets both C and S Categories, ~~it is suggested that~~ the C Service Category should be put first so that the consumer can recognize that the oil is primarily a diesel engine oil but also meets S Service Category requirements. For an oil that is formulated for passenger car motor oil applications and meets both S and C Service Categories, ~~it is suggested that~~ the S Service Category should be put first so that the consumer can recognize that the oil is primarily a passenger car motor oil but also meets C Category requirements.

5.3.2 Service Categories for Passenger Car Motor Oils

5.3.2.1 SP—2020 Gasoline Engine Warranty Maintenance Service

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

Engine oils that meet the API Service Category SP designation (see Annex G) may be used where API Service Category SN and earlier S categories have been recommended.

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

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

5.3.2.2 SN—2011 Gasoline Engine Warranty Maintenance Service

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

Engine oils that meet the API Service Category SN designation (see Annex G) may be used where API Service Category SM and earlier S categories have been recommended.

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

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

5.3.2.3 SM—2005 Gasoline Engine Warranty Maintenance Service

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

Engine oils that meet the API Service Category SM designation (see Annex G) may be used where API Service Category SL and earlier S Categories have been recommended.

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

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

5.3.2.4 SL—2001 Gasoline Engine Warranty Maintenance Service

API Service Category SL was adopted for use in describing engine oils available in 2001. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures.

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

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

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

5.3.2.5 SJ—1997 Gasoline Engine Warranty Maintenance Service

API Service Category SJ was adopted for use in describing engine oils available in 1996. These oils are for use in service typical of gasoline engines in passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures.

Engine oils that meet the API Service Category SJ designation (see Annex G) may be used where API Service Category SH and earlier S Categories have been recommended.

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

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

~~**5.3.2.5 SH—1994 Gasoline Engine Warranty Maintenance Service**~~

~~API Service Category SH was adopted in 1992 for use in describing engine oils available in 1993. These oils are for use in service typical of gasoline engines in passenger cars, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures.~~

~~Engine oils developed for this Service Category provide performance exceeding the minimum requirements for API Service Category SG, which Service Category SH was intended to replace, in the areas of controlling deposits, oil~~

~~oxidation, wear, rust, and corrosion and must meet the engine-protection sequence test requirements of DOD CID-A-A-52039A (document obsolete) and ILSAC GF-1. In addition, all viscosity grades designated in DOD CID-A-A-52039A (SAE 5W-30, 10W-30, and 15W-40) must meet the bench test requirements described in DOD CID-A-A-52039A and ILSAC GF-1. (SAE 15W-40 does not have a phosphorus limitation and does not have to meet the GM filterability test.)~~

~~Engine oils that meet the API Service Category SH designation (see Annex G) have been tested in accordance with the ACC Code, may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Engine Testing (see Annexes E and F), and may be used where API Service Category SG and earlier S Categories have been recommended.~~

~~Engine oils that meet these requirements may not display API Service Category SH in the upper portion of the API Service Symbol unless SH is preceded by a C Category.~~

5.3.2.6 Resource Conserving Oil Classification for Gasoline-Powered Passenger Cars, Sport Utility Vehicles, Vans, and Light-Duty Trucks

5.3.2.6.1 General

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

5.3.2.6.2 Resource Conserving in Conjunction with API Service Category SP

API Service SP engine oils designated as Resource Conserving are formulated to help improve fuel economy and protect vehicle emission system components in passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have demonstrated a fuel economy improvement (FEI) in a specific sequence test at the percentages listed in Table 1 when compared with a baseline oil (BL). Additionally, these oils have demonstrated in other tests listed in Table 1 that they provide greater emission system and turbocharger protection and help protect engines when operating on ethanol-containing fuels up to E85.

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

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

Table 1—Resource Conserving Primary Performance Criteria with API Service Category SP

Performance Test	Performance Criteria	
	FEI SUM	FEI2 minimum after 125 hours aging
Sequence VIE (ASTM D8114)[a]		
Viscosity Grade		
XW-20	3.8%	1.8%
XW-30	3.1%	1.5%
10W-30 and all other viscosity grades not listed above	2.8%	1.3%
Sequence VIF (ASTM D8226)[a]		
Viscosity Grade		
XW-16	4.1%	1.9%
Sequence IIIHB (ASTM D8111)	81% phosphorus retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits, TEOST 33C (ASTM D6335), Total Deposit Weight, mg		
SAE XW-16, 0W-20	Not Required	
All other viscosity grades	30 max	

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

5.3.2.6.3 Resource Conserving in Conjunction with API Service Category SN

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

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

Starting October 1, 2010, oils that have passed the tests at the limits shown in Table 2 and are properly licensed by API may display “Resource Conserving” in the lower portion of the API Service Symbol in conjunction with API Service SN in the upper portion. The fuel economy and other resource conserving benefits obtained by individual vehicle operators using engine oils labeled Resource Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits. ~~Before the October 1, 2010, introduction date, oil marketers may license oils meeting Resource Conserving in conjunction with API Service SN as Energy Conserving in conjunction with API Service SM.~~

Table 2—Resource Conserving Primary Performance Criteria with API Service Category SN

Performance Test	Performance Criteria	
	FEI SUM	FEI2 minimum after 100 hours aging
Sequence VID (ASTM D7589[a])		
Viscosity Grade		
XW-16	2.8%	1.3%
XW-20	2.6%	1.2%
XW-30	1.9%	0.9%
10W-30 and all other viscosity grades not listed above	1.5%	0.6%
Or		
Sequence VIE (ASTM D8114[a])		
Viscosity Grade		
XW-20	3.2%	1.5%
XW-30	2.5%	1.2%
10W-30 and all other viscosity grades not listed above	2.2%	1.0%
Sequence VIF (ASTM D8226[a])		
Viscosity Grade		
XW-16	3.7%	1.8%
Sequence IIIGB (ASTM D7320)	79% phosphorus retention min	
Or		
Sequence IIIHB (ASTM D8111)	81% phosphorus retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits, TEOST 33C (ASTM D6335), Total Deposit Weight, mg		
SAE XW-16, 0W-20	Not Required	
All other viscosity grades	30 max	

[a]Viscosity grades are limited to 0W, 5W and 10W multigrade oils.
[b]Resource Conserving does not apply to 5W-16.

5.3.2.6.4 SN PLUS Classification in Conjunction with API Service Category SN and API SN with Resource Conserving

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

Oils that meet the requirements for API SN with SN PLUS or API SN with SN PLUS and Resource Conserving at the limit shown in Annex G, Table G-4, and are properly licensed may display “SN PLUS” or “Resource Conserving SN PLUS” in the lower portion of the API Service Symbol in conjunction with API SN in the upper portion (see Figures 3 and 4).

Oils that satisfy SN PLUS can also effectively lubricate engines calling for API SN, API SN with Resource Conserving, or ILSAC GF-5. API SN with SN PLUS and API SN with SN PLUS and Resource Conserving are also backward compatible to API Service Categories before API SN.

Figure 3—API SN with SN PLUS

Figure 4—API SN with SN PLUS and Resource Conserving

~~**5.3.2.5.3 Energy Conserving in Conjunction with API Service Category SM**~~

~~API Service SM engine oils designated as Energy Conserving are formulated to improve the fuel economy of passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have produced a fuel economy improvement (FEI) both at the start and end of the Sequence VIB test at the percentages listed in Table 2, when compared with the standard reference oil (ASTM Reference Oil BC) used in the Sequence VIB test.~~

~~Oils that meet the Sequence VIB requirement and are properly licensed may display "Energy Conserving" in the lower portion of the API Service Symbol in conjunction with API Service Category SM in the upper portion. The fuel economy obtained by individual vehicle operators using engine oils labeled Energy Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits.~~

~~**Table 2—Sequence VIB Primary Performance Criteria with API Service Category SM**~~

~~Viscosity Grade~~	~~FEI1 relative to BC, min~~	~~FEI2 relative to BC, min~~
~~0W-20 and 5W-20~~	~~2.3%~~	~~2.0%~~
~~0W-30 and 5W-30~~	~~1.8%~~	~~1.5%~~
~~10W-30 and all other viscosity grades not listed above~~	~~1.1%~~	~~0.8%~~

~~**5.3.2.5.4 Energy Conserving in Conjunction with API Service Category SL**~~

~~API Service Category SL engine oils categorized as Energy Conserving are formulated to improve the fuel economy of passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have produced a fuel economy improvement (FEI) both at the start and end of the Sequence VIB test at the percentages listed in Table 3, when compared with the standard reference oil (ASTM Reference Oil BC) used in the Sequence VIB test.~~

~~Oils that meet the Sequence VIB requirement and are properly licensed may display "Energy Conserving" in the lower portion of the API Service Symbol in conjunction with API Service Category SL in the upper portion. The fuel economy obtained by individual vehicle operators using engine oils labeled Energy Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits.~~

~~Table 3—Sequence VIB Primary Performance Criteria with API Service Category SL~~

~~Viscosity Grade~~	~~FEI1 relative to BC, min~~	~~FEI2 relative to BC, min~~	~~Sum of FEI1 + FEI2, min~~
~~0W-20 and 5W-20~~	~~2.0%~~	~~1.7%~~	~~—~~
~~0W-30 and 5W-30~~	~~1.6%~~	~~1.3%~~	~~3.0%~~
~~10W-30 and all other viscosity grades not listed above~~	~~0.9%~~	~~0.6%~~	~~1.6%~~

~~5.3.2.5.5 Energy Conserving in Conjunction with API Service Category SJ and SH~~

~~Energy Conserving claims are not permitted with API Service Categories SJ and SH.~~

5.3.3 Service Categories for Diesel Engine Oils

5.3.3.1 CK-4—For 2017 Heavy-Duty Diesel Engine Service

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

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

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

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

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

5.3.3.2 FA-4—For 2017 Heavy-Duty Diesel Engine Service

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

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

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

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

5.3.3.3 CJ-4—For 2010 Severe-Duty Diesel Engine Service

API Service Category CJ-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2010 model year on-highway and Tier 4 nonroad exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust aftertreatment system durability and/or oil drain interval.

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

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

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

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

5.3.3.4 CI-4—For 2004 Severe-Duty Diesel Engine Service

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

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

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

API CI-4 oils are superior in performance to those meeting API CH-4 and may be used in engines calling for that API Service Category. Marketers may license products meeting API CI-4 requirements as API CH-4.

5.3.3.5 CH-4—For 1998 Severe-Duty Diesel Engine Service

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

These oils are especially effective to sustain engine durability even under adverse applications that may stress wear control, high-temperature stability, and soot handling properties. In addition, optimum protection is provided against non-ferrous corrosion, oxidative and insoluble thickening, foaming, and viscosity loss due to shear.

These oils also have the performance capability to afford a more flexible approach to oil drain intervals in accordance with the recommendations of the individual engine builders for their specific engines.

Engine oils that meet the API Service Category CH-4 designation have been tested in accordance with the ACC Code of Practice and may use the API Base Oil Interchangeability Guidelines and the API Guidelines for SAE Viscosity-Grade Read Across (see Annexes E and F).

CH-4 oils are superior in performance to those meeting API CF-4 and API CG-4 and can effectively lubricate engines calling for those API Service Categories.

5.3.4 CI-4 PLUS Classification in Conjunction with API Service Category CI-4, CJ-4, and CK-4

API Service Category CI-4, CJ-4, and CK-4 engine oils that also carry the classification CI-4 PLUS are formulated to provide a higher level of protection against soot-related viscosity increase and viscosity loss due to shear in vehicles powered by diesel engines.

Oils that meet the requirements for CI-4 PLUS as defined in Annex S and are properly licensed may display “CI-4 PLUS” in the lower portion of the API Service Symbol in conjunction with API CI-4, CJ-4, and/or CK-4 in the upper portion (see Figure 5).

Oils that satisfy CI-4 PLUS are superior in performance to those meeting API CI-4 and CH-4 and can effectively lubricate engines calling for those API Service Categories.

Figure 5—CI-4 PLUS Classification

5.4 SAE Viscosity Grades Eligible for Use with API Marks

The SAE viscosity grades eligible for use with the API Marks are specified in Table 3. Refer to SAE J300 for the most current SAE Viscosity Classification requirements.

Table 3—SAE Viscosity Grades Eligible for Use with API Marks

Low-Temperature Viscosity Grade	High-Temperature Viscosity Grade						
	—	16	20	30	40	50	60
—		Y	Y	Y	Y	Y	Y
0W	Y	Y	XY	XY	XY	XY	XY
5W	Y	Y	XY	XY	XY	XY	XY
10W	Y	Y	XY	XY	XY	XY	XY
15W	Y	Y	Y	Y	Y	Y	Y
20W	Y	Y	Y	Y	Y	Y	Y
25W	Y	NA	NA	Y	Y	Y	Y

Note: X = eligible for the API Certification Mark, provided the oil meets all license requirements outlined in this publication for the API Certification Mark; Y = eligible for the API Service Symbol, provided the oil meets all license requirements outlined in this publication for the API Service Symbol; NA = not applicable.

6 License System for API Marks

6.1 General

6.1.1 The API EOLCS is a voluntary licensing and certification program designed to define, certify, and monitor engine oil performance deemed necessary for satisfactory equipment life and performance by vehicle and engine manufacturers. Its purpose is to ensure that engine oils meeting the minimum performance standards of vehicle and engine manufacturers are easily identified by consumers.

6.1.2 To use either of the two API Marks, an engine oil marketer must apply for and obtain a license from API. The application steps the marketer must complete and the information the marketer must submit to API to secure the right to use the API Marks are provided in the EOLCS Online Application at http://engineoil.api.org (see Annex H). A marketer desiring to apply for a license must complete the Online Application. Licenses are valid from the date of license approval until March 31 of the next year as long as all program requirements continue to be met. Annual renewals are issued when all renewal steps are completed.

6.2 Licensing Fees

6.2.1 Licensees pay API licensing fees to support EOLCS. These fees are reviewed annually. The current fee structure is available on-line at https://www.api.org/products-and-services/engine-oil/application-and-fees.

6.2.2 Applicants pay a nonrefundable fee at time of application. The application fee is per license, not per product licensed. The application fee is the same if the applicant applies to license one engine oil or many.

6.2.2.1 Current licensees pay an annual minimum licensing fee and an additional annual licensing fee for each gallon of packaged and bulk API-licensed oil sold after the first million gallons.

6.2.2.2 Applicants are only assessed the application fee in their initial year of licensing. The additional fee based on a licensee's volume of API-licensed oil sold is charged to the licensee at time of license renewal. To renew an API license, the licensee must report the volume of all API-licensed oils (packaged and bulk) sold in the prior year. Volume-of-sales figures will be held in strict confidence by API.

6.3 Responsibility of Marketers

6.3.1 Only an engine oil marketer may apply for and be awarded a license to display an API Mark. [See the glossary (Annex I) for a definition of marketer.]

6.3.2 As noted in the licensing agreement, the marketer is solely responsible for ensuring that the performance characteristics of the oil product displaying an API Mark or Marks meet all requirements for the Mark or Marks. If multiple Service Categories are used, the marketer must ensure that the oil meets the minimum performance requirements for each of the Service Categories designated. If, in obtaining a license for use of an API Mark, a marketer chooses to use either the API Base Oil Interchangeability Guidelines or API Guidelines for SAE Viscosity-Grade Read Across, that marketer is also responsible for correctly applying those guidelines. The most recent version of the guidelines can be obtained on-line at https://www.api.org/products-and-services/engine-oil/documents.

6.4 Licensing Procedures

6.4.1 A valid API license permits the marketer to use the API Marks on its licensed oils and is that marketer's warranty that its licensed oils comply with licensing requirements. The EOLCS Online Application requires applicants to certify that licensed oils meet EOLCS requirements and to abide by all the requirements of the program and the licensing agreement.

6.4.2 The EOLCS Online Application specifies the certified information applicants must submit to demonstrate that their oil or oils meet specific Service Categories or the current ILSAC specification and are eligible for one or both of the API Marks. The information required is also addressed in Annex H. This includes certification by the marketer that each brand and viscosity grade of the engine oil for which licensing is requested meets the most recent version of prescribed technical criteria as set forth in the following standards:

a. ASTM D4485.
b. SAE J300.
c. SAE J183 ~~for oils not designated Energy Conserving~~.

The EOLCS Online Application may include additions, deletions, or other modifications to the standards listed above.

6.4.3 The EOLCS Online Application includes but is not limited to the following certification statements:

a. Any engine tests covered by the ACC Code of Practice and in the API licensing program must be conducted in accordance with the latest edition of the ACC Code of Practice (see Annex J).
b. Any Base Oil Interchangeability or Viscosity-Grade Read Across Guidelines must be applied in accordance with Annexes E and F.

The EOLCS Online Application clearly states that the use of API Base Oil Interchangeability Guidelines and API Guidelines for SAE Viscosity-Grade Read Across does not absolve the marketer of the responsibility to meet minimum performance standards for the licensed oils.

6.4.4 The applicant is required to submit the following information (based on the final engine oil formulation) for each product to be considered for licensing (note that a difference in viscosity grade, Service Category, or brand name denotes a separate engine oil):

a. Elemental analysis data.
b. Finished oil physical properties.
c. Additive and base oil information.
d. Engine test information (stand code from applicable category engine test, base oil interchange/viscosity grade read across use).
e. Product traceability code information.

The EOLCS Online Application specifies that all licensed oils are subject to monitoring and enforcement procedures, including audits.

6.4.5 After the marketer has completed the application process, paid the fee, and been granted the license, the marketer may display the API Marks on licensed products in accordance with Section 7.

6.4.6 API maintains strict confidentiality of all proprietary data provided by license applicants. Information submitted is used only as specified in the license agreement.

6.5 Renewals

A license may be renewed annually by mutual agreement of the parties, provided the licensee reports the volume of licensed product sold the previous year, pays the annual fee, and agrees to comply with any amendments to the license agreement and any modifications or additional specifications of the license requirements.

6.6 System Monitoring and Enforcement

The integrity of the API EOLCS is maintained by means of a formal monitoring and enforcement program, as defined in Section 8.

6.7 Provisional License

6.7.1 On rare occasions, a test or tests specified under API licensing requirements for API S, C, or F Service Categories or ILSAC minimum performance standards may be declared by ASTM Subcommittee D02.B0 to be "out of control" or "unavailable" or determined by API to be "unavailable." Reasons for these declarations or determinations may be due to various factors such as a severity shift in the test results, shortage of test materials, an industry-wide test-related emergency, lack of test availability at independent test labs, or another situation that prevents tests from being run. ASTM D02.B0 may declare a test "out of control" when the test's surveillance panel and classification panel have judged the test to be giving uninterpretable performance. ASTM D02.B0 and its panels may also declare a test to be "unavailable" in accordance with ASTM Subcommittee B Test Availability Guidelines. In a case where ASTM determines that a test is "available" and API determines that the same test is "unavailable," API's determination will stand with regard to enacting provisional licensing. API may make its own determination that a test is "unavailable" for reasons noted above and particularly in situations where independent test labs can no longer run a test or tests. When a test or tests are declared "out of control" or determined to be "unavailable," API may grant a provisional license or licenses to an applicant if the candidate engine oil meets all API licensing requirements except for the test or tests that are "out of control" or "unavailable."

6.7.2 When a test or tests are "out of control" or "unavailable," API will evaluate the impact of their loss on the Engine Oil Licensing and Certification System. The evaluation will include the following:

a. Test performance measurement or parameter affected.
b. Reason the test or tests are "out of control" or "unavailable."
c. Proposed issue resolution and the time necessary to implement the resolution.
d. Test recertification plan.
e. Any alternative test/data options available to provide indication of suitable performance.

API will perform its evaluation and report the results of its evaluation to the Lubricants Standards Group. The result of the API evaluation will be reported to Lubricants Standards Group with recommendations on Provisional Licensing.

6.7.3 When a test or tests are expected to be "out of control" or "unavailable" for an undetermined, indefinite period of time, API will consider alternative tests and seek advice from the AGP, Lubricants Standards Group members, lab personnel, and others who have experience with category test replacement. If API recommends and the Lubricants Standards Group agrees, a task force will be formed, and API will follow the steps included in 6.8.

6.7.4 Where a test or tests are approaching end of life (on the basis of parts availability), API may institute active monitoring of test availability if the queued requests received at independent labs significantly exceed those labs' capacity of tests. This monitoring may lead to API declaring the test "unavailable."

6.7.5 API will notify all API licensees, the Lubricants Standards Group, the Alliance, EMA, JAMA, and ACC of the date on which any test required for an API license is declared "out of control" or "unavailable" and the date on which the test is declared "no longer out of control" or "no longer unavailable".

6.7.6 All applications for a provisional API license shall include data that support the performance of the candidate engine oil in the test or tests not conducted. Ideally, these data shall conform to Level 2 Support, as described in Tab 1 of the ACC Code. In the absence of Level 2 Support data, the licensee shall submit technical information that demonstrates that the candidate engine oil would likely pass the "out of control" or "unavailable" test or tests.

6.7.7 A request for provisional licensing of an oil is made by checking the provisional licensing box in the EOLCS Online Application. This box should only be checked if a product or formulation does not have a passing result in the test or tests declared "out of control" or "unavailable" at the time of application. The box must not be checked if an applicant is waiting for test results on available tests.

6.7.8 When the API Base Oil Interchangeability Guidelines are used to "interchange" a base oil in a new formulation or the Guidelines for SAE Viscosity-Grade Engine Testing are used to "read across" from a provisionally licensed engine oil, the licensee must indicate provisional status on the EOLCS Online Application for that engine oil.

6.7.9 After a test is "no longer out of control or unavailable" and API has forwarded this information to each licensee holding a provisional license, the licensee holding the provisional license must obtain a passing result on that test. At minimum, the licensee will be given 6 months to obtain a passing result, but more time may be granted if test length or other factors warrant a longer testing period.

6.7.9.1 Upon passing the test, the licensee will request full licensing of the oil by submitting a revised formulation for the provisionally licensed oil and withdrawing the provisionally licensed formulation. The EOLCS Online Application System requires a brand to have at least one valid formulation to remain a licensed brand. This would also apply to any provisionally licensed "interchange" or "read across" oils arising from 6.7.8.

6.7.9.2 If a revised formulation for the provisionally licensed oil is not received by API within the allotted timeframe included in the "no longer out of control or unavailable" notification to licensees, API will withdraw the provisionally licensed oil and notify the licensee that the API S, C, or F Service Category in the API Service Symbol and/or the API Certification Mark shall no longer be displayed on the label of that engine oil or any engine oil that was provisionally licensed based on that engine oil (per 6.7.8).

6.7.10 Engine oils granted an API provisional license will be listed in API's Directory of Licensees on API's website in the same manner as API-licensed oils, without any special designation. The licensee is still responsible for the satisfactory performance of all engine oils granted an API provisional license, per the provisions of Section 4.

6.8 Formation of Task Force to Establish Alternatives or Replacement Tests for Out of Control or Unavailable Tests

6.8.1 When API and the Lubricants Standards Group agree that a task force should be formed to establish alternative tests addressing the loss of a test or tests declared "out of control" or "unavailable," the task force shall be formed as indicated below:

a. For tests necessary to validate an oil's eligibility for a license to display the API Certification Mark or an API S Service Category in the API Service Symbol, a task force shall be formed from API and automotive representatives from API's Administrative Guidance Panel (AGP).
b. For tests necessary to validate an oil's eligibility for a license to display a current API C or F Service Category in the API Service Symbol, a task force shall be formed from API and EMA.
c. For tests necessary to validate an oil's eligibility for a license to display simultaneously the API Certification Mark or current API S, C, or F Service Categories in the API Service Symbol, a task force shall be formed from API, AGP automotive representatives, and EMA.

Each of the above-mentioned groups (API, AGP, and EMA) shall select three members to participate on the task force. The task force may also invite other industry representatives as advisory, non-voting members to ensure the right level of technical expertise is available to understand the potential impact of allowing provisional licensing. In all cases, API staff shall act as facilitators for the task force or task forces.

6.8.2 The task force shall complete a comprehensive review that may include the following:

a. Evaluating reasons for the "out of control" or "unavailable" declaration.
b. Conducting a risk assessment and drawing conclusions.
c. Recommending a course of action.
d. Recommending when to cease provisional licensing.

6.8.3 The appropriate specification-development bodies (AOAP for S Service Categories and DEOAP for C and F Service Categories) are responsible for evaluating and approving plans intended to resolve "out of control" or "unavailable" declarations related to S, C, or F Service Categories under their purview.

6.8.4 The task force or task forces will make best efforts to supplement the activities of any one test's Surveillance Panel by providing new options and occasionally supporting resolution efforts through funding and/or providing in-kind contributions (for example, test parts, test materials, and oils).

6.9 Emergency Provisional Licensing

6.9.1 If a supply of base oil or additives utilized by a number of licensees is disrupted, licensees may apply for short-term Emergency Provisional Licenses. A disruption is defined as a significant industry-wide limitation on the supply of a base oil or additive that makes it impossible for multiple licensees to market sufficient quantities of engine oil without violating the API licensing agreement. The disruption must be caused by an unforeseeable event involving, but not limited to, an explosion, fire, legal action, natural disaster, or act of terrorism that is beyond the control of individual licensees.

6.9.2 The licensee's application for an Emergency Provisional License must include a detailed description of the event that created the need for the Emergency Provisional License; the steps that have been taken by the licensee to find other sources of licensable materials, including both raw materials and finished products; an estimate of the duration of the shortage; and other supporting information required by API. The licensee must also submit technical information that supports, to the satisfaction of API, that the use of the substitute component will not adversely affect the claimed performance standards of the licensed product.

6.9.3 The initial term of the Emergency Provisional License will be granted for up to 90 days. At the discretion of API, this license period may be extended beyond the 90-day term. The Emergency Provisional License is intended to last only until the licensee obtains alternative supplies of materials, completes additional requirements as defined by API, or the disruption ends, whichever is earlier. The Emergency Provisional License will be conditioned upon the licensee fully complying with requirements and other conditions imposed by API to protect consumers and the integrity of the program.

6.9.4 Relief under this section will rarely be granted by API. The burden is on the licensee to establish clearly that there are exigent circumstances that justify the use of this type of remedy and that the failure of the licensee to obtain supplies of base oil, additives, or finished products was not caused by the licensee's negligence or failure to utilize good business practices.

7 Use and Labeling Requirements for API Marks

7.1 API Engine Oil Quality Marks

7.1.1 API licenses three types of engine oil quality marks: the API Certification Mark "Starburst" (see Figure 6), the API Certification Mark "Shield" beginning on May 1, 2020 (Figure 7), and the API Service Symbol "Donut" (see Figures 8 and 9). The marketer may display an API Mark, as described in this section, only after obtaining a license to use the specific API Mark. Under the terms of the License Agreement, marketers may use the Marks in a number of ways: for example, on containers of licensed products [bottles, cans, jugs, kegs, drums, intermediate bulk containers (IBC), tanks, etc.]; in advertisements of licensed products; and in materials describing licensed products.

7.1.2 API will provide licensed marketers with "camera-ready" quality images or electronic versions (TIF, EPS, JPG, and BMP) of the API Marks, on request, for use in producing final artwork.

7.1.3 The API Certification Mark "Starburst" and API Certification Mark "Shield" may be used with the API Service Symbol "Donut" if the marketer meets all licensing requirements for the API Marks for that viscosity grade of engine oil. Note that a difference in viscosity grade, Service Category, or brand name denotes a separate engine oil. The API Marks shall be located and displayed as described in 7.2 through 7.4.

7.2 API Certification Mark "Starburst"

7.2.1 If the API Certification Mark "Starburst" is used, it shall be clearly displayed on the front of the container of those engine oils that have been properly licensed by API. Note that this does not prevent the licensed marketer from displaying the API Certification Mark again on the back of the container.

7.2.2 The outside diameter of the API Certification Mark "Starburst" (measured from the outside tips) shall be at least 2.1 centimeters and shall be 1.5 (±0.1) times the inside diameter. The background of the outer band (containing the words AMERICAN PETROLEUM INSTITUTE and CERTIFIED) shall be a color that contrasts with the label background. (For example, if the label background is white, the outside band could be black with the words in white.)

Figure 6—API Certification Mark "Starburst"

The background of the inner circle shall be a color that contrasts with the outer band. The words AMERICAN PETROLEUM INSTITUTE and CERTIFIED in the outer band of the API Certification Mark and the words FOR GASOLINE ENGINES in the center shall be all capital letters. The relationship of the letter size to the allocated space within the API Certification Mark must be consistent for all users of the API Certification Mark. All lettering used for words in the API Certification Mark must be identical for all licensees.

7.2.3 API has registered the API Certification Mark only in the English language, and it can be displayed only as registered and shown in Figure 6. However, the purpose of the API Certification Mark is to assist consumers, so API encourages licensed marketers to translate the words CERTIFIED and FOR GASOLINE ENGINES into any appropriate language outside of the API Certification Mark. The translation must be literal and provided to API as part of the licensing agreement. The location of the translations can be anywhere on the front of the label but not within a mark or symbol of any kind. AMERICAN PETROLEUM INSTITUTE is also a licensed mark and cannot be translated without permission of API.

7.3 API Certification Mark "Shield"

7.3.1 If the API Certification Mark "Shield" is used, it shall be clearly displayed on the front of the container of those engine oils that have been properly licensed by API. Note that this does not prevent the licensed marketer from displaying the API Certification Mark "Shield" again on the back of the container.

7.3.2 The length of the API Certification Mark "Shield" (measured from the top to the bottom of the shield) shall be at least 2.1 centimeters. The inner shield shape (containing the words AMERICAN PETROLEUM INSTITUTE and CERTIFIED FOR GASOLINE ENGINES) and the line denoting the outer shield shape shall be a matching color that contrasts with the label background. (For example, if the label background is a lighter color such as yellow, the inner and outer shields should be a darker color with the lettering inside the inner shield displayed in a lighter color such as the background yellow or white.)

Figure 7—API Certification Mark "Shield"

The words AMERICAN PETROLEUM INSTITUTE and CERTIFIED FOR GASOLINE ENGINES and the acronym SAE and letter "W" in the SAE viscosity shall be all capital letters. The relationship of the font size to the allocated space within the API Certification Mark "Shield" must be consistent with the design shown in Figure 7. A sans serif font must be used for all lettering.

7.3.3 API has registered the API Certification Mark "Shield" only in the English language, and it can be displayed only as registered and shown in Figure 7. However, the purpose of the API Certification Mark "Shield" is to assist consumers, so API encourages licensed marketers to translate the words CERTIFIED FOR GASOLINE ENGINES into any appropriate language outside of the API Certification Mark "Shield." The location of the translation can be

anywhere on the front of the label but not within a mark or symbol of any kind. AMERICAN PETROLEUM INSTITUTE is also a licensed mark and cannot be translated without permission of API.

7.4 API Service Symbol "Donut"

7.4.1 The API Service Symbol "Donut" may be located anywhere on the outside of the container. The outside diameter of the API Service Symbol shall be 1.9 times the inside diameter. The Service Category must be placed in the upper part of the Donut, the SAE viscosity grade in the center, and the optional Resource Conserving, CI-4 PLUS, and SN PLUS classifications in the lower part. The API Service Symbol shall be large enough for the lettering to be legible and shall strictly conform to the design (including the required information and its placement) shown in Figure 8.

Figure 8—API Service Symbol "Donut"

7.4.2 Beginning December 1, 2016, when API Service FA-4 is claimed, the upper half of the Service Symbol must be divided by a single vertical line, and the API Service Categories and phrase "API Service" must appear as shown in Figure 9 (Service Categories left and "API Service" right of vertical line). Note that licensed FA-4 oils shall use a Service Symbol that conforms to the divided upper half designs in Figures 9 and 10.

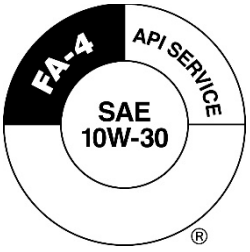


Figure 9—API Service Symbol "Donut" with API FA-4

7.4.3 API Service Symbols may appear as black and white, reversed out, or in color. Examples of acceptable designs are provided in Figures 9 and 10. Any color is acceptable provided the design conforms to the designs shown in Figures 8 through 10.

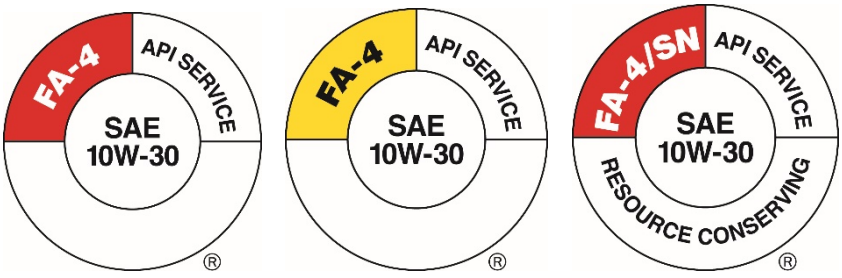


Figure 10—Representative Examples of the API Service Symbol with FA-4

7.4.4 Use of the API Service Symbol is restricted to current API Service Categories [namely, SN; SM; SL; SJ; ~~SH (when used as described in 7.3.3)~~, CH-4; CI-4; ~~and~~ CJ-4; CK-4, FA-4 and beginning May 1, 2020, SP]. Except as prohibited in 5.3.3, these may appear alone or in combination with other current Service Categories. The API Service Categories must appear in the upper part of the API Service Symbol, but such placement does not preclude their use

elsewhere on the container. Use of API Service Categories SA, SB, SC, SD, SE, SF, SG, SH, CA, CB, CC, CD, CD-II, CE, CF, CF-2, CF-4, and CG-4 within the API Service Symbol is prohibited (see Annex A).

7.4.5 Use of more than one API S Service Category in the API Service Symbol is prohibited. SAE 0W-16 and 5W-16 oils may only be licensed as API SN, API SN with Resource Conserving, API SN with SN PLUS, and API SN with SN PLUS and Resource Conserving. Beginning on May 1, 2020, SAE 0W-16 and 5W-16 oils may be licensed as API SP, API SP with Resource Conserving, API SP with SN PLUS, and API SP with SN PLUS and Resource Conserving ~~Service Category SH cannot be used in the API Service Symbol unless preceded by CH-4 and/or CI-4 and/or CJ-4~~.

If API C Service Category oils are licensed for more than one current Service Category, these oils may display the Service Categories in the upper part of the API Service Symbol. Except as specified above, if the engine oil marketer chooses to include API C Service Categories with a current API S Category, a virgule (/) must be placed between the API S Service Category and the API C Service Categories, which are separated by commas. Licensees of Service Category C oils may use the C Categories first. Examples of acceptable notations are “API Service SN”; “API Service CK-4”; “API Service CJ-4,CI-4/SM”; “API Service SJ”; “API Service CJ-4/SM”; “API Service CI-4”; and “API Service CH-4.” Figure 11 shows examples of notations for various Service Categories used within the API Service Symbol.

For an oil that is formulated for diesel engine applications and meets both C and S Categories, ~~it is suggested that~~ the C Category should be put first so that the consumer can recognize that the oil is primarily a diesel engine oil but also meets S Category requirements. Conversely, for an oil that is formulated for passenger car motor oil applications and meets both S and C Categories, ~~it is suggested that~~ the S Category should be put first so that the consumer can recognize that the oil is primarily a passenger car motor oil but also meets C Category requirements. ***Some automobile manufacturers are concerned that engine oils with greater than 800 parts per million (0.08% mass) phosphorus can adversely affect catalytic converters in gasoline-fueled engines.***

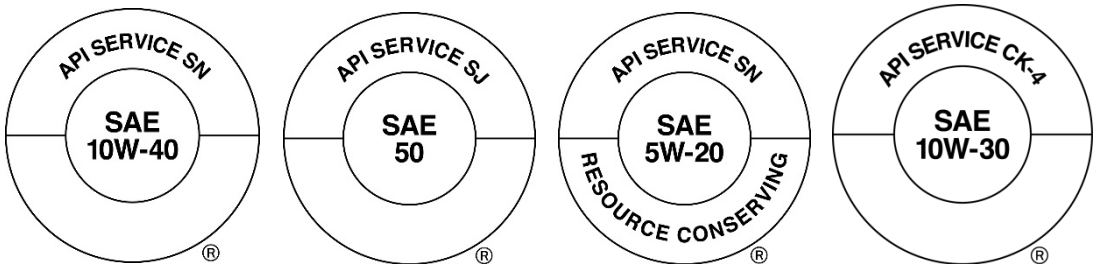


Figure 11—Representative Examples of the API Service Symbol

7.5 Product Traceability Coding

7.5.1 For purposes of conformance audits, the marketer shall ensure that product traceability codes appear on each container and that these codes are legible and durable. Each container shall be coded to permit traceability of samples in the marketplace by formulation, date of packaging, and source of manufacture.

7.5.2 The marketer may use whatever coding system is appropriate or convenient. Disclosure of coding systems to API is required in the EOLCS Online Application (see Annex H). No change in coding is permitted without prior notification of API. Coding information provided to API is considered confidential and will be used only as described in the API license agreement.

8 System Monitoring, Enforcement, and Conformance

8.1 General

8.1.1 API’s Aftermarket Audit Program (AMAP) is a monitoring and enforcement program designed to ensure compliance by marketers (licensees) with the licensing requirements of the API EOLCS at the time of initial licensure as well as in the aftermarket. Monitoring and enforcement efforts are directed to confirm that, for each licensed product: (a) at licensure, the physical and chemical properties of the licensed formulation for such product, as described in the finished oil physical properties and elemental analysis sections of the EOLCS Online Application (the “Licensed Fingerprint”), have met the product qualifications claimed in the formulation information in the Online Application and paragraph 6.4.2; (b) each licensed product, as marketed, conforms to the Licensed Fingerprint for

that product; and (c) the API marks are properly displayed on licensed product containers and convey accurate information to consumers about the contents.

8.1.2 To ensure continued compliance with API licensing requirements, the Licensed Fingerprint of an engine oil will be used to determine whether the engine oil being marketed is in compliance with the data submitted in the EOLCS Online Application. API may review the information furnished by applicants in the EOLCS Online Application pursuant to paragraph 6.4.4. This will include, where applicable, API securing and reviewing with the applicant the underlying engine, bench, and analytical testing data from the licensee and program information to confirm that the applicable criteria set forth in API 1509 and in ASTM D4485 have been met.

a. Where the applicable information includes engine and/or bench testing, API shall confirm that the licensee has passing test results for the licensed product, whether full or provisional, that establish that the licensed product met API's standards at initial licensure (or any amended licensure). API shall then determine continued compliance with API's standards for licensure by confirming that the licensed product, as marketed, conforms to the Licensed Fingerprint. As stated in 6.3.2, the marketer is solely responsible for ensuring that the performance characteristics of the oil product displaying an API Mark or Marks meet all requirements for the Mark or Marks.
b. Where applicable read across guidelines are employed in lieu of engine testing, API shall confirm that the licensee has passing test results for the formulation tested, whether full or provisional, that establish that the licensed product met API's minimum performance standards for licensure at initial licensure (or any amended licensure). API shall then determine continued compliance with API's standards for licensure by confirming that the licensed product, as marketed, conforms to the Licensed Fingerprint and the guidelines have been properly interpreted and applied. In addition, to ensure proper interpretation and application of read across guidelines, prior to and after licensure API may require selected applicants to review in detail with API how such guidelines were interpreted and applied by the applicant. No such review with API shall absolve a marketer of the responsibility for correctly applying read across guidelines.

8.1.3 To ensure that licensed products, as marketed, conform to their respective Licensed Fingerprints, API will annually secure samples of brands and viscosity grades of randomly selected licensed products. Licensees shall be required to use reasonable efforts to ensure that such samples are made available to API. Each of the samples will be analyzed according to a standard audit (see Annex K) that compares the physical and chemical property audit data with the Licensed Fingerprint for the licensed product in question. Test results must meet the physical and chemical tolerances described in Annex K. API shall consider a sampled oil as in compliance with the API standards for licensure if the oil tested matches the Licensed Fingerprint (see 8.1.2). Of the oils found to meet the bench and analytical standards, some may be randomly chosen (see Annex L) for engine testing to determine compliance with engine test standards. Engine test results are evaluated using the methodology specified in Annex M. In cases of engine test failure, API shall confirm that the licensed product complies with paragraph 8.1.2. This includes a complete review of all engine, bench, and analytical testing results supporting the licensed product. If API is unable to confirm that the licensed product complies with paragraph 8.1.2, API shall notify the licensee and take appropriate action as provided in 8.2.1.

Where the applicable criteria allow the use of read across guidelines in lieu of specified bench and analytical testing, licensees may be required to run bench and analytical tests if the licensed product fails to conform to the Licensed Fingerprint for that product.

8.1.4 Engine oils will be chosen for engine test audits based on a randomly generated list of API licensees, weighted by volume (see Annex L).

8.1.5 API will contract with independent organizations to collect samples from the field and conduct all physical and chemical analyses, bench tests, and engine tests.

8.1.6 Data obtained through the Aftermarket Audit Program are considered confidential, are available only to the appropriate API staff and the licensee, and are used only for the purposes stated in the inquiry. Specific data derived from the Aftermarket Audit Program will not be used for any reason other than the monitoring process without written permission from the licensee. When summary data are issued by API, they will not be company specific.

8.2 Violations

8.2.1 General

Violations of the EOLCS are divided into two categories: (a) noncompliance with technical specifications and (b) improper use of the API Marks.

8.2.1.1 Noncompliance with Technical Specifications

If an API-licensed oil does not meet technical specifications, API will attempt to work directly with the marketer to evaluate the nonconformity and take additional corrective action as appropriate on a voluntary basis. If the matter cannot be satisfactorily resolved, API will take or initiate the actions listed below, singly or in combination, to maintain the credibility of the API Mark and protect the consumer. Enforcement action will be related to the severity of the alleged offense, the period of time that the violating product has been in the marketplace, the efforts made by the marketer to correct the violation, and the possible harmful impact on the consumer. These actions include the following:

a. Temporary suspension of the authority of the licensee to use the API Mark on a product until corrective action has been taken.
b. Termination of the authority of the licensee to use the API Mark on an individual product.
c. Termination of the authority of the licensee to use the API Mark on all API-licensed products marketed by the licensee.
d. Requirement for the licensee to remove noncomplying products that display API Marks from the marketplace.

Note: All monitoring and enforcement actions must be resolved to API's satisfaction before an existing license will be renewed or a new license issued.

8.2.1.2 Improper Use of API Marks

If licensed or unlicensed oils display an improper label or unauthorized labeling data, API will require the marketer to cease and desist from committing the violation and will request verification that the violation has been corrected.

8.2.2 Verification of Compliance with API Enforcement Action

API will take steps to verify that required corrective action has been executed. Actions requested to verify compliance will depend on the seriousness of the violation. The cost of these verification procedures will be borne by the marketer, as specified in the license agreement. Verification procedures include the following:

a. Submission of copies of labels. The marketer will be required to provide a copy of all labels reflecting the correction of the API Mark violation.
b. Attestations. The marketer will be required to furnish an affidavit from a third party (a law firm or an accounting firm) that the specified remedial action has been completed.
c. Retesting. The marketer will agree to undertake any agreed-upon retesting.
d. Other evidence of compliance. API can make other reasonable requests to verify compliance.

8.2.3 Appeals

When API suspends or revokes a license, the former licensee may appeal the decision. Appeals must be submitted in writing to the Director, Global Industry Services. The appeal shall include a statement of the basis for the objection. The appeal must be filed with API within 45 days of the date of notification of the suspension or revocation of the license. The API Director shall investigate the objections raised and respond to them in writing within 45 days of receipt. If the objections cannot be resolved by the Director, a hearing by a designated appeals board shall be convened in accordance with API Policy 602.

Annex A

Evolution of Engine Oil Classifications

In 1911, SAE developed a system that classified engine oils by viscosity. This engine oil classification system remained in place until 1947, when API designated three types of engine oils: regular, premium, and heavy duty. Generally, the regular oils were straight mineral oils, the premium oils contained oxidation inhibitors, and the heavy-duty oils contained both oxidation inhibitors and detergent-dispersant additives.

Recognizing the inadequacy of this designation system, in 1952 API's Lubricants Committee, in cooperation with ASTM, developed the Engine Service Classification System (ESCS). API and ASTM revised ESCS in 1955 and again in 1960. ESCS separated gasoline and diesel engine performance with Service Categories ML, MM, and MS and DG, DM, and DS, respectively.

In 1969 and 1970, API, ASTM, and SAE established an entirely new classification system that would satisfy the changing warranty, maintenance, and lubrication requirements of the automotive industry. SAE initially determined that there were eight separate Service Categories of passenger car engine oils of current substantial commercial interest to be considered. ASTM established the test methods and performance characteristics and technically described each of the Service Categories. API prepared a user language, including new letter designations for each of the eight Service Categories. These eight engine Service Categories were tied to the ASTM technical description and primary performance criteria. SAE then published results of the entire project and the methodology as SAE J183.

Over the years, API, ASTM, and SAE have established new Service Categories and declared old Service Categories technically obsolete: The three organizations declared Gasoline Engine Service Category SA technically obsolete; Service Categories SB, SC, SD, SE, SF, and SG became technically obsolete when test methods were no longer available to verify performance; and Diesel Engine Service Categories CA, CB, CC, CD, CD-II, CE, CF, CF-2, CF-4, and CG-4 also became technically obsolete when test methods were no longer available to verify performance or the API Lubricants Committee voted by letter ballot to make a category or categories obsolete. Table A-1 lists all technically obsolete Service Categories.

In 1992 and 1993, API, ASTM, and U.S. and Japanese automotive manufacturers introduced improvements in the licensing process for engine oils to ensure the quality of products being marketed and to enhance consumer awareness of the recommended lubricants for new vehicles. This improved process is known today as the API Engine Oil Licensing and Certification System (EOLCS).

Table A-1—Summary of Obsolete Service Categories and Related Military and Industrial Designations

Technically Obsolete API Service Categories	Previous API Service Categories	Related Military and Industrial Designations
Automotive Gasoline Engines (Passenger Car Engine Oils)		
SA	ML	Straight mineral oil
SB	MM	Inhibited oil, minimum duty
SC	MS (1964)	1964 MS warranty approved, M2C101-A
SD	MS (1968)	1968 MS warranty approved, M2C101-B, 6041-M (before July 1970)
SE	None	1972 warranty approved, M2C101-C, 6136-M (previously 6041-M Rev.), MIL-L-46152A
SF	None	1980 warranty approved, M2C153-D, MIL-L-46152B/C, 6048-M, 6049-M
SG	None	1989 warranty approved, MIL-L-46152D/E
SH	None	None
Commercial Diesel Engines (Diesel Engine Oils)		
CA	DG	MIL-L-2104A
CB	DM	Supplement 1
CC	DM	MIL-L-2104B, MIL-L-46152B
CD	DS	MIL-L-45199B, Series 3, MIL-L-2104C/D/E
CD-II	None	MIL-L-2104D/E
CE	None	None
CF	None	None
CF-2	None	None
CF-4	None	None
CG-4	None	None

Annex B

Interindustry Advisory Group to API/Automotive Manufacturers Administrative Guidance Panel on API EOLCS

B.1 Scope

The Interindustry Advisory Group (IAG) will provide recommendations to the API/Automotive Manufacturers Administrative Guidance Panel (AGP) on proposed modifications to the API EOLCS.

B.2 Function

The group will review, evaluate, and make recommendations on EOLCS matters, including tolerance limits, the Aftermarket Audit Program, the ACC Code of Practice, and any other issues relevant to the licensing program.

B.3 Organization

Each of the following organizations will be invited to provide one representative to the group: ACC, API, ASTM, Automotive Manufacturers, Truck and Engine Manufacturers Association (EMA), Independent Lubricant Manufacturers Association (ILMA), Japan Automobile Manufacturers Association (JAMA), Petroleum Association of Japan (PAJ), SAE, and the U.S. Army. Representatives from other organizations may be added to the group as deemed necessary by the AGP. A group member serves at the discretion of the sponsoring organization and is charged with addressing improvements and concerns from his or her organization's perspective. Therefore, there will be no fixed term of membership for the group members.

B.4 Officers

The chair of the IAG is the API representative. The chair calls the meetings, sets the agenda, and presides.

The vice chair of the IAG is rotated annually between an Automotive Manufacturer and an EMA representative. The vice chair assists the chair and presides when the chair is absent.

The secretary of the IAG is the API EOLCS Manager. The secretary assists the chair, arranges meetings, drafts minutes, and handles the group's correspondence.

B.5 Meetings

The intent is to meet at the call of the chair, not to exceed two meetings per year. Where possible, group meetings will be held in conjunction with other scheduled meetings that are widely attended by industry. Meetings will be held in accordance with API policy.

B.6 Decision Making

The chair will attempt to achieve group consensus on issues before a formal vote. Lacking consensus, standard voting procedures will be followed, with a simple majority of voting members present at the meeting required to carry any motion. Each organization will have a single ballot in each formal vote. The chair will allow dissenting voters to present their views when forwarding the outcome of votes.

Annex C

Developing New Engine Oil Performance Standards for API Certification Mark

C.1 General

One of the objectives of API's voluntary Engine Oil Licensing and Certification System (EOLCS) is to help consumers identify engine oils recommended by vehicle and engine manufacturers. To accomplish this objective, the International Lubricant Specification Advisory Committee (formerly International Lubricant Standardization and Approval Committee) (ILSAC) and API created in 1993 the API Certification Mark. The API Certification Mark, or "Starburst" for short, is a Registered Mark that clearly identifies passenger car engine oils meeting the latest engine oil performance standard adopted by ILSAC and API.

This annex outlines the primary process used to set specifications for certain passenger car engine oils and describes the procedures that API will use to determine whether these specifications become a standard against which engine oil marketers are licensed to use the API Certification Mark.

Vehicle and engine manufacturers, technical societies, trade associations, lubricant and additive marketers, independent testing laboratories, and consumers play essential roles in defining and developing new minimum performance standards for engine oils. To allow balanced input from all interested industry participants, API will give strong preference to accepting engine tests that are under the jurisdiction of ASTM subcommittee D02.B0, monitored by the ASTM test monitoring center, and under the governance of an ASTM surveillance panel.

C.2 Auto/Oil Advisory Panel

The Auto/Oil Advisory Panel (AOAP) develops the specifications against which engine oil marketers are licensed to use the API Certification Mark. The AOAP guides and facilitates the development and introduction of AOAP performance specifications for passenger car engine oils.

C.2.1 Membership Updated with API Proposal

AOAP shall consist of voting and liaison members that have a material interest in developing passenger car engine oil specifications. Material interest includes the following:

a. Any gasoline-fueled automotive engine manufacturer that recommends the standard, or
b. Manufacturers of a gasoline-fueled automotive engine that might use an oil meeting the standard, or
c. Manufacturers or marketers of an oil that meets the standard, or
d. Manufacturers of a component used to formulate oil that meets the standard.

Voting members shall represent companies that are members in good standing in the API Lubricants Standards Group, ACC Petroleum Additives Panel, ILMA, Alliance of Automobile Manufacturers, or JAMA; and liaison member representatives of companies that are members in good standing in ASTM, SAE, or STLE. Representatives from the U.S. Army would also be included as liaison members.

A company that wishes to be a voting member of AOAP shall submit a written request to API that includes a brief explanation of the company's material interest in the specification and proof of membership in one of the organizations identified above. API will maintain the list of companies that have requested membership and met membership qualifications.

Companies with a material interest that participate in other trade organizations not listed in this Annex may request liaison membership by writing to API. The written request must explain the organization's interest in engine oil specifications. Representatives of companies who request membership shall be granted membership if a vote for their inclusion, taken by existing AOAP members, leads to a simple majority of affirmative votes. Such a vote can take place during either a meeting or a conference call. An organization's initial request for membership must be made at least 1 month before the initiation of a precision matrix supporting the specification.

Members must demonstrate active participation in the development of the standard by attending meetings and voting or commenting on issued ballots. Failure to attend at least one meeting per year or to vote on two consecutive letter ballots shall result in the removal of the representative from the panel roster.

API and the Alliance shall each designate a co-chair for the panel. The responsibility of the co-chairs is agreed upon by the AOAP. These typically include setting meeting agendas, reviewing actions, and calling for votes when required. API will provide administrative support such as making meeting arrangements and distributing meeting announcements and minutes.

A panel member may send a proxy to participate in the panel, and the proxy's participation counts toward a member's requirement to actively participate in the panel. If a member chooses to send a proxy, the member shall provide the name of the proxy to API in writing before the start of a scheduled AOAP meeting or conference call. Notification may be made by email or letter. Proxies are not necessary for representatives from the same company.

Changes to company voters shall be provided to API in writing.

C.2.2 Voting

The AOAP shall attempt to reach consensus on issues related to needs and the issuance and finalization of a draft specification. A quorum of two thirds of both industries (auto and oil) is required for AOAP to conduct official business. Consensus is established when substantial agreement has been reached by the panel. Substantial agreement means more than a simple majority but not necessarily unanimity. Consensus requires that all views and objections be considered and that an effort be made toward their resolution. For purposes of these procedures, consensus shall be defined as follows:

a. Voting is balanced or weighted to ensure ratios of 50 percent Auto and 50 percent Oil.
b. Two-thirds of Auto and two-thirds of Oil votes cast, less waives, are affirmative.
c. Fifty percent of all possible votes are affirmative on each side.

Consensus is defined as noted above and each negative vote shall be accompanied by the information below. A letter ballot (electronic ballot) should be used whenever negative votes are cast during AOAP meetings:

a. Specific paragraph, section, or part negative ballot pertains to.
b. Specific substantive reason(s) for negative vote.
c. Proposed wording or action to resolve negative vote.

Additionally, each abstention shall be explained in writing.

Ballots shall be qualified and negatives and comments considered and resolved in accordance with the latest edition of API's *Procedures for Standards Development*.

If AOAP cannot achieve consensus on the draft specification, then ILSAC may issue a draft for industry comment pursuant to C.3.2.4. If AOAP cannot achieve consensus on the final specification, then ILSAC may issue a specification pursuant to C.3.3.2. If AOAP cannot achieve consensus on needs, the Administrative Guidance Panel will convene pursuant to C.4.3.

C.2.3 Procedures

The AOAP shall provide an adequate level of due process by ensuring the following:

a. All meetings of the AOAP where the proposed specifications are discussed, decisions made, or votes taken are open to all interested parties.
b. Interested parties are given a meaningful opportunity to comment on draft specifications. Comments received by the AOAP shall be reviewed and evaluated pursuant to the consensus criteria specified in C.2.2. The AOAP shall document responses to comments received on the draft specifications.
c. Any party having a material interest in the process has the right to bring a timely appeal of an AOAP action or decision. Appeals must be submitted in writing to the Co-Chairs of the AOAP. If the objections cannot be resolved by the Co-Chairs, the appeal will be transmitted to an API appeals board for resolution. Appeals shall be addressed following the process defined in the latest edition of API's *Procedures for Standards Development*.

C.3 AOAP Development Process

The AOAP specification development process is designed to accomplish the following:

a. Validate the need for a new specification.
b. Achieve stakeholder consensus early in the process.
c. Optimize the process for developing and approving new specifications.

A new specification is developed in steps, some of which are conducted in parallel and provide input to subsequent steps, as summarized in Figure C-1, Process of Developing New Engine Oil Performance Standards for the API Certification Mark.

C.3.1 Determination of Need

C.3.1.1 Request for a New Specification

Any individual, company, or association may request a new definition of oil performance that may eventually result in a new specification. To invoke the evaluation process, the new specification request must be submitted to the Co-Chairs of the AOAP and to the Chair of the API Lubricants Standards Group.

The request for a new specification must include adequate data and justification for the proposed specification. The request must demonstrate a need for significant oil performance changes to meet requirements not met by existing categories. Justification should include, but is not limited to, one or more of the following:

a. Impending government regulations.
b. Consumer-driven needs.
c. New hardware design or service requirements.
d. Field problems encountered with current oils.

Following the receipt of the new specification request, the Co-Chairs will notify ILSAC and the API Lubricants Standards Group of the proposed specification and request that the associations confirm that AOAP should evaluate the need for the specification.

C.3.1.2 Evaluation Criteria

The AOAP will work to reach a consensus position on the need and timing for the new specification by considering the following questions:

a. What is the proposed change and why is it required?
b. Does data presented support the request?
c. When is it needed in the marketplace?
d. What are the potential impacts on engines?
e. What are the potential impacts on consumers?
f. What are the potential impacts on the environment?
g. How could the change affect existing API categories? Could an existing API category satisfy the need expressed?
h. What performance and field tests are needed to properly evaluate the performance needs requested?
i. Are the tests available now? If not, in what timeframe can the performance and field tests be developed?

The AOAP may solicit additional industry input and data at any time to assist it in reaching a decision. Other industry groups [for example, SAE, API Detroit Advisory Panel (DAP), and EMA] may be asked to provide supplemental information.

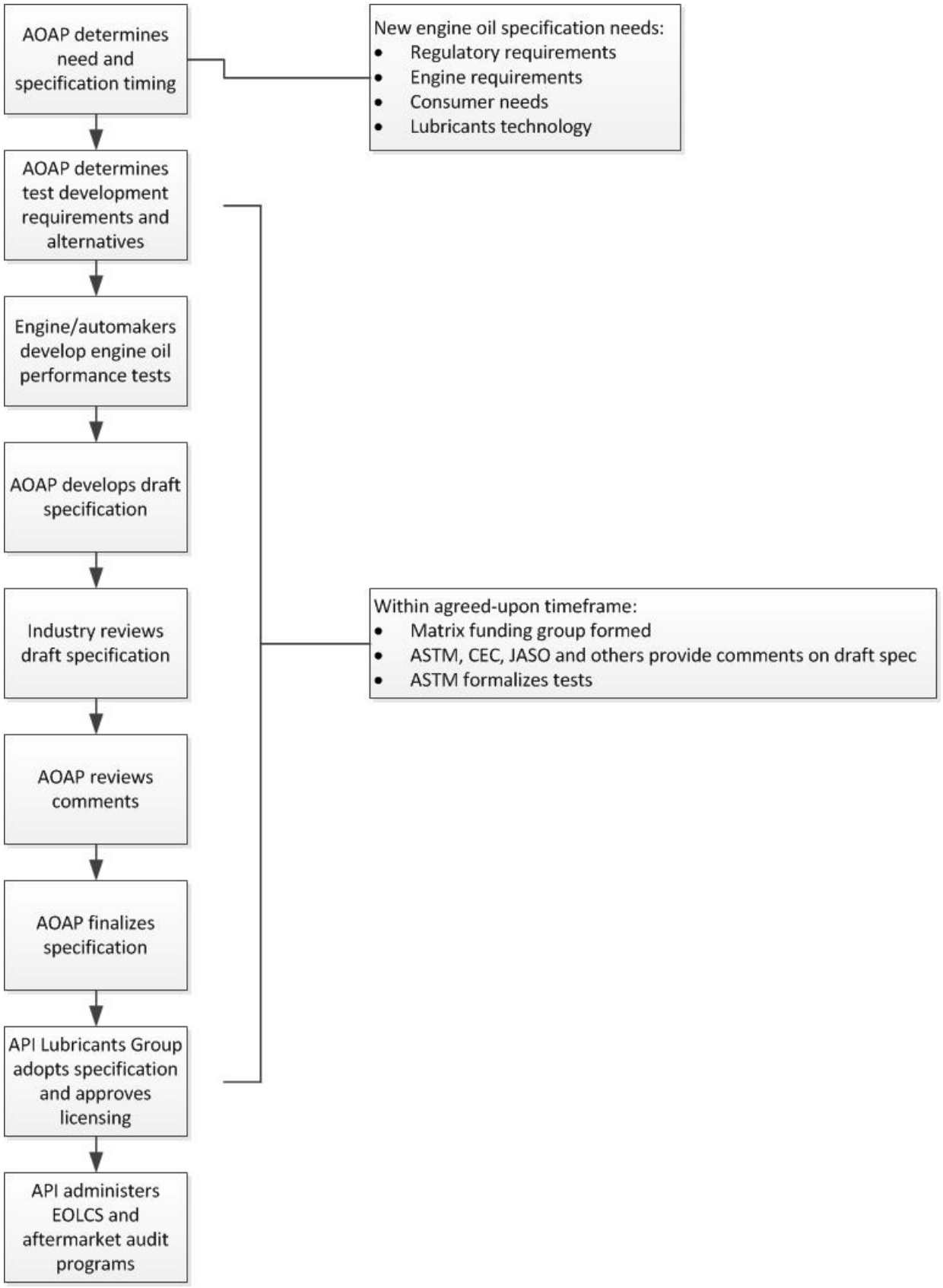


Figure C-1—Process for Developing New Engine Oil Performance Standards for API Certification Mark

C.3.1.3 Decision on Need

The AOAP shall evaluate the request pursuant to the consensus process outlined in C.2.2 and make one of the decisions below:

a. Support the request for the new AOAP specification and proceed with development. This recommendation shall document the basis for determining that there is a need for the new specification.
b. Deny the request.
c. Determine that it cannot reach consensus.

The sponsor has the option of resubmitting the request with additional information if the AOAP denies the request or is unable to reach consensus. If the AOAP cannot achieve consensus on needs after reviewing the additional information, the Administrative Guidance Panel will convene pursuant to C.4.3.

C.3.2 Specification Development

When the AOAP approves the request for the development of a new specification, the AOAP will proceed with development. Parties such as ACC, ASTM, SAE, ILMA, and independent test laboratories may be requested to assist in the development process. Other national, regional, or international bodies—for example, Japanese Automobile Standards Organization (JASO) and Conseil Europeen de Coordination pour les Dévelopments des Essais de Performance des Lubrifiants et des Combustibles pour Moteurs [Coordinating European Council (CEC)]—may also be asked for input during this process.

C.3.2.1 Timing

The AOAP will draft a timetable for the development of a new specification to enable the issuance of the AOAP specification and licensing of products with the API Starburst at the earliest practicable date. That timetable will indicate the dates at which specific development milestones should be reached and the date first allowable licensing of the Starburst should occur for the new specification. The resulting timeline shall be reviewed periodically. In all timetable reviews, the date proposed for first licensing shall allow oil marketers a reasonable opportunity to perform the testing required for licensing prior to the first-license date.

Prior to the start of any precision matrixes, the elements of the timeline should be formally agreed upon by AOAP voting members, recognizing that circumstances could change the timeline and the subsequent changes shall be agreed upon by AOAP voting members before the timeline is considered in agreement by AOAP.

C.3.2.2 Identification of Test Development Needs and Alternatives

If an appropriate test method is not available, a new test method must be developed. Test procedures may be developed or modified by ASTM, CEC, JASO, or other technical societies or trade associations, an OEM, or a third-party contractor. AOAP decides the appropriateness of the tests in the proposed specification per C.2.2.

The AOAP will monitor the specification development process to ensure adherence to the approved timeline. The AOAP will also develop alternative methods of satisfying the specification needs in the specified timeline to ensure that unanticipated problems or situations will not have the potential to unduly delay specification development. If a test or a performance measurement is not ready by the scheduled time, a replacement shall be developed or the requirement dropped.

Any change in the timeline and/or change in the specification shall require AOAP approval as described in C.2.2.

C.3.2.3 Development of ILSAC Draft

C.3.2.3.1 Review of Proposed ILSAC Draft Specifications

After agreement has been reached on the need, tests and alternatives have been identified, and timing has been established, the AOAP is charged with developing a draft specification. Performance-based rather than composition-based standards should be used to the maximum extent feasible. The AOAP may consider proposed requirements submitted by any stakeholder in the engine oil specification development process (ILSAC, API, ACC, a company, an individual, or another association). After considering these inputs, the AOAP may send its proposed draft to the ASTM

Passenger Car Engine Oil Classification Panel (PCEOCP) for review within a specified timeframe. If appropriate, the AOAP may also send the proposed draft to JASO and/or CEC.

As necessary, the ASTM PCEOCP, JASO, and/or CEC will be asked to review the proposed draft, and within a specified timeframe, prepare an informal report for the AOAP to consider. The following inputs will be requested from the ASTM PCEOCP and, if necessary, JASO and CEC during this review:

a. The groups will evaluate the proposed draft specification and limits and provide comments on whether the proposed test methods will evaluate the needs defined by the AOAP.
b. Each group will be requested to issue a report to the AOAP that contains a summary of comments and data received during the group's proceedings.

While the AOAP may seek input from ASTM, PCEOCP, JASO, and CEC, the AOAP can proceed with specification development if the results of these reviews are not delivered within a specified timeframe. Pursuant to the consensus process specified in C.2.2, the AOAP will issue a draft AOAP specification for review and comment by all interested parties (see C.3.2.4).

C.3.2.3.2 Formalization of Tests

Once a new test becomes available (e.g., shows satisfactory discrimination of oil performance) pursuant to C.3.2.2, the appropriate industry group, for example ASTM, CEC, JASO, or other, will determine test precision.

For example, if an engine test is being developed by ASTM, the AOAP will provide a specified timeframe to ASTM. It is ASTM's responsibility to have a functioning task force or surveillance panel in place to coordinate activities and analyze test data including determining when a test is ready for matrix testing. For bench tests, ASTM must provide a method for referencing and/or calibrating each bench test that does not have an assigned surveillance panel. Based on the AOAP's agreed upon timeline, ASTM will also develop a timetable that contains, among other things, planned dates for reference oil selection, bench and engine test selection, and test method completion. The objective is to formalize the tests and establish criteria to demonstrate that the tests are precise, are reproducible, and have the ability to discriminate. All applicable engine and bench tests shall be monitored by the TMC (or equivalent) prior to incorporation into the final specification (see C.3.3).

If ASTM fails to discharge these responsibilities in a timely manner, the AOAP shall take appropriate actions to ensure that the timing identified in C.3.2.1 for implementing the specification will be met. This may include developing an AOAP specification containing alternative test methods.

C.3.2.3.3 Specification Development Funding

The testing necessary for determining precision as described in C.3.2.3.2 often requires funding. At times, funding might also be required for engine testing to establish base oil interchange (BOI) and viscosity grade read across (VGRA) guidelines, studies, and consumer education. For previous ILSAC specifications, the Alliance for Automobile Manufacturers, JAMA, API, and ACC have provided this funding. When precision and BOI/VGRA testing or other funding is required, the Lubricants Standards Group shall form a task force to evaluate the need and develop a plan for raising the funding. This funding task force will be composed of volunteers from the Lubricants Standards Group, the Alliance, ACC, ILMA, ASTM, and JAMA. For new performance standards, the funding group shall fulfill its role by at least addressing the following points:

a. Calculate the amount of funding necessary for precision and BOI/VGRA matrix testing as recommended by the matrix design task force.
b. Solicit funding for proposed precision and BOI/VGRA matrix testing.
c. If necessary, modify the matrix testing design to match the funding available.
d. Develop a Memorandum of Agreement (MOA) for precision and BOI/VGRA matrix testing.
e. Ensure all companies and organizations that agree to fund the matrix sign the MOA.

C.3.2.4 Industry Review of ILSAC Draft Specification

The draft AOAP specification developed in C.3.2.3 will be circulated to all interested parties for comment. The AOAP will solicit comments in writing and will hold public forums as deemed appropriate. The AOAP will review the comments and data from the industry received in C.3.2.3 before determining the requirements and limits for the final specification. If there are significant changes in the requirements between the draft and the final specification, the

AOAP will conduct another comment period on the revised specification. All comment periods will be for a period of at least 30 days. A longer review period may be allowed for comments on an initial draft. If AOAP cannot achieve consensus on the draft specification, then ILSAC may issue a draft for industry comment as indicated in C.2.2 above.

In parallel with industry review of the draft AOAP specification, API will solicit data on specification demonstration oils (see item b of C.3.3.1) in such a manner as to maintain confidentiality of individual company data.

C.3.3 Specification Finalization

C.3.3.1 Review of Development Process

At or near the end of the development of the new specification (e.g., prior to C.3.3.2), the AOAP shall confirm that the following items have been addressed:

a. (1) The tests developed satisfy the needs agreed to by the AOAP, (2) the performance descriptions contained in the proposed consumer language are met by the tests proposed for the specification, (3) the timetable is acceptable, (4) and the test methods chosen to define the new standard represent the best means of establishing the new performance level.
b. Available data on demonstration oils have been reviewed. A demonstration oil shows the technical and commercial viability of the proposed new engine oil specification. This is an oil formulated with base stock and additive components expected to be commercially available when licensing of the new specification begins. Ideally the oils shall have been tested in and passed, at the proposed limits, all engine, chemical, physical, and bench tests required in the draft specification, according to the ACC Code of Practice[1] in effect at the time the tests are run (for engine tests). Registration is not needed, but stand calibration is required.
c. If sufficient information on a demonstration oil is not available, AOAP will re-evaluate the draft specification for technical and commercial viability. While information on a demonstration oil is useful as input to the limit-setting process and may help achieve consensus, the demonstration oil is not required prior to achieving the AOAP consensus pursuant to item a of C.3.3.2.
d. All industry comments on the proposed specification have been reviewed to ensure that they have been considered and addressed by the AOAP in sufficient detail.

C.3.3.2 Approval of the Final AOAP Specification

When AOAP agrees that the original goals and objectives of the specification appear to have been met, AOAP will promptly convene to vote on acceptance of the final AOAP specification. If AOAP approves the final specification in accordance with the procedures in C.2.2, the specification will be forwarded to the API Lubricants Standards Group for consideration for adoption into API 1509.

C.4 API Lubricants Standards Group Adoption of AOAP Specification

C.4.1 A meeting of the API Lubricants Standards Group will be scheduled as soon as possible after API has received the final AOAP specification or the specification has been issued unilaterally by ILSAC. The Lubricants Standards Group will vote whether to accept the AOAP specification or the specification issued unilaterally by ILSAC as the basis for licensing of the API Starburst via letter ballot pursuant to API *Procedures for Standards Development*.

The Chair of the Lubricants Standards Group will resolve negative ballots and comments in accordance with the latest edition of API's standards procedures.

C.4.2 When submitting an AOAP specification that has been approved pursuant to C.3.3.2, AOAP must provide documentation that the following criteria have been satisfied:

a. Complied with due process requirements.
b. Provided justification for overriding any technical objections raised during the AOAP process.
c. Provided data on at least one demonstration oil meeting all of the requirements defined in item b of C.3.3.1 at the time the specification is delivered, provided such data has been made available.
d. Showed that the AOAP specification oil will be reasonably achievable and will likely be widely available to consumers within the specified timeframe (e.g., recommended additional time for compliance).

[1] Provided the AOAP has accepted the Code of Practice as a basis for engine testing.

e. Based on data from items c and d above, showed that the AOAP specification provides significantly more needed benefits to consumers (as identified in C.3.1) than any other specification proposal the AOAP considered.

C.4.3 If the API Lubricants Standards Group does not adopt the AOAP specification or if the AOAP cannot achieve consensus on needs, the Administrative Guidance Panel will either withdraw the request for a new specification or convene to consider dissolution of the Certification system.

Annex D

Developing New Diesel Oil Performance Standards for API C Service Categories

D.1 General

One of the objectives of API's voluntary Engine Oil Licensing and Certification System (EOLCS) is to help consumers identify lubricants that meet the needs of their vehicles. This is accomplished through the use of category designations within the API Service Symbol. These categories are based on engine oil performance specifications that require close coordination and consensus among the affected parties. Technical societies, trade associations, lubricant and additive marketers, vehicle and engine manufacturers, independent testing laboratories, and consumers play essential roles in defining and developing new minimum lubricant performance standards. This annex outlines the roles and responsibilities of each organization in the heavy-duty diesel oil specification development process for API licensing.

API is responsible for licensing engine oil marketers against and enforcement of lubricant performance standards adopted for use in EOLCS. The API Lubricants Standards Group must grant final approval to any new category and recommend its inclusion in EOLCS.

D.2 API C Service Categories for Diesel Oils

The C Service Category Development Process for diesel oils is designed to accomplish the following:

a. Justify and validate the need for a new category.
b. Achieve stakeholder consensus early in the process.
c. Establish funding sources for all necessary category components.
d. Optimize the process for developing and approving new categories.

A new C category is developed in three phases, as summarized in Figure D-1.

D.3 Category Development Phases

D.3.1 Phase 1: Category Request/Evaluation

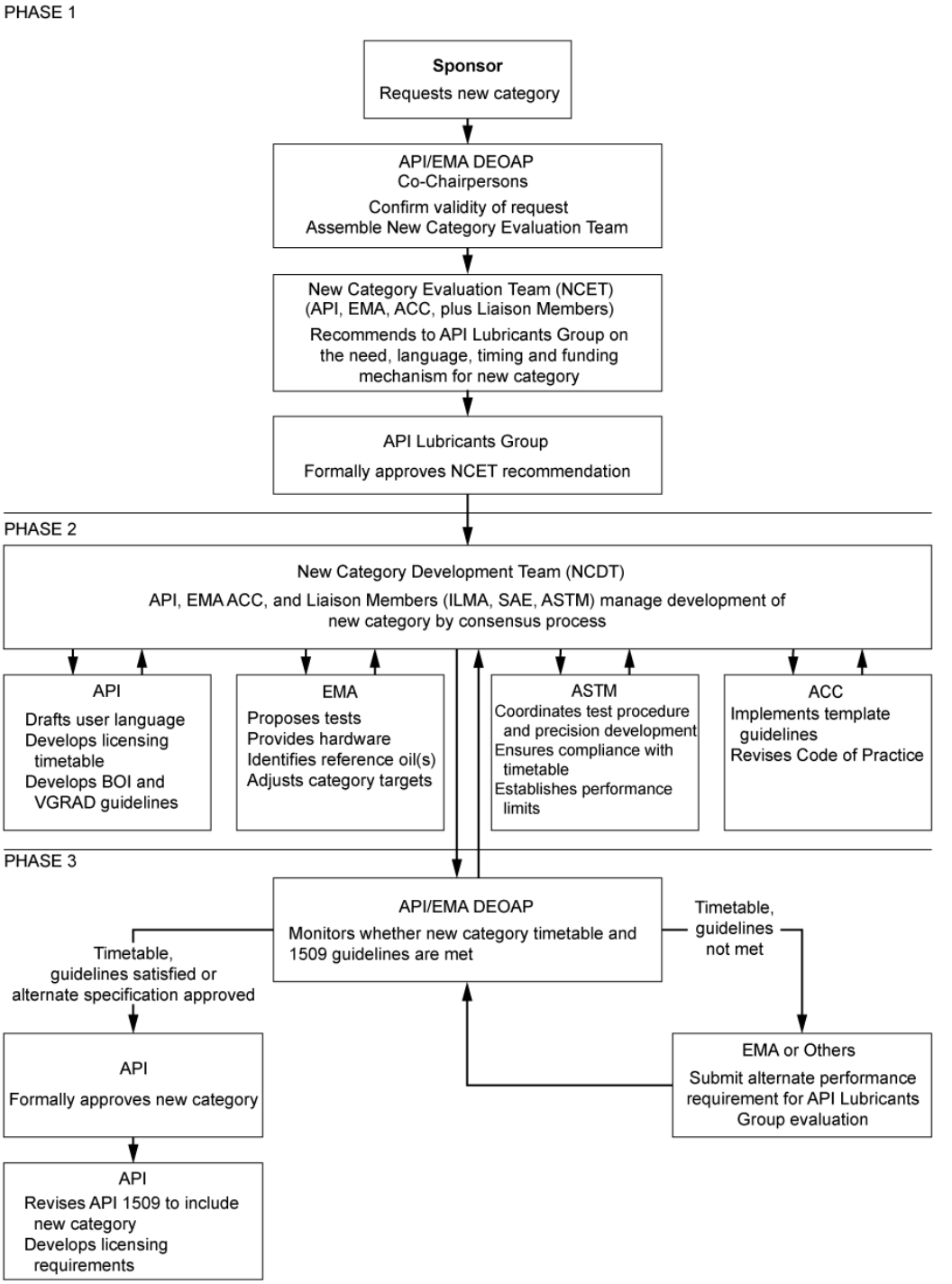
D.3.1.1 Sponsor

A new definition of oil performance that may eventually result in a new category can be requested by any individual, company, or association (see Figure D-2). This party is referred to as the sponsor of the request.

D.3.1.2 Evaluation Process

The purpose of the evaluation process is to determine whether there is a need for the proposed category. To invoke the evaluation process, a sponsor must submit a new category request to the Chairpersons of the Joint API/EMA Diesel Engine Oil Advisory Panel (DEOAP).

The DEOAP is a formally constituted committee composed of representatives from API and EMA member companies who deal with heavy-duty lubricant matters affecting the two trade associations. The DEOAP will guide and facilitate the introduction of proposed heavy-duty performance categories. In addition to DEOAP members, liaison representatives from allied organizations—for example, ACC, SAE, ASTM, ILMA, and the U.S. Army—may also participate.



ACC = American Chemistry Council
ASTM = American Society of Testing and Materials
BOI = Base Oil Interchange
DEOAP = Diesel Engine Oil Advisory Panel
EMA = Engine Manufacturers Association
ILMA = Independent Lubricant Manufacturers Association
SAE = Society for Automotive Engineers
VGRA = Viscosity Grade Read-Across

Figure D-1—Heavy Duty Category Request/Approval Process

The Chairpersons of the DEOAP will acknowledge the receipt of the new category request and will work with the category sponsor to furnish the DEOAP with the information necessary to make a decision. The DEOAP has 6 months from the date that all the requested information has been presented to make a decision to either accept or reject the request for a new category. If no decision on the request is made within 6 months, it is automatically forwarded to the API Lubricants Standards Group for its members' information and disposition.

The sponsor must provide adequate data and justification for the proposed category. The request must demonstrate a need for significant oil performance changes to meet requirements not met by existing categories. Justification should include, but is not limited to, one or more of the following:

a. Likely or impending government regulations.
b. Consumer-driven needs.
c. New hardware design or service requirements.

D.3.1.3 New Category Evaluation Team (NCET)

The Chairpersons of the DEOAP will ask API, EMA, and ACC to appoint representatives to serve on an ad hoc review team that will formally evaluate each request for a new category—a New Category Evaluation Team (NCET).

NCET membership will be limited to the minimum number needed to accomplish the work while remaining consistent with full technical representation. This number may vary depending on the requested category. API, EMA, and ACC may each have up to three representatives on the NCET. At the first meeting, the NCET will develop working rules, elect a chairperson, decide who to invite as liaison representatives, and request a meeting with the sponsor. The API, EMA, and ACC representatives are equal participants and decision making by consensus will be strongly encouraged. However, if that is not possible, decision making will be assumed by API and EMA representatives through majority vote. In the case of a tie vote, the request will be addressed by the DEOAP. All NCET meetings will be open to API, EMA, and ACC member company representatives and others.

D.3.1.3.1 NCET Evaluation Responsibilities

The NCET will work to reach consensus positions on the following questions:

a. What is the proposed change and why is it required?
b. Does data presented support the request?
c. When is it needed in the marketplace?
d. What are the potential impacts on engines?
e. What are the potential impacts on consumers?
f. What are the potential impacts on the environment?
g. How could the change affect existing API categories?
h. Are performance tests available that properly evaluate the performance needs requested?
i. Do the perceived benefits outweigh the projected costs?
    1. How much will it cost to develop test procedures and determine precision and define, if necessary, Base Oil Interchange (BOI) and Viscosity-Grade Read Across (VGRA) Guidelines for the proposed category?
    2. What is the estimated total cost to carry out projected work for the new category if the need is approved?

Note: The DEOAP is responsible for calculating an estimated total cost for developing the proposed category and ensuring that an agreement in principle is reached on category development funding before submitting the request to the API Lubricants Standards Group. To that end, the DEOAP Co-Chairpersons will establish an ad hoc Task Force for that specific purpose. This group should include representatives from the principal stakeholders in the process: API, EMA, ACC, independent test laboratories, and other parties deemed appropriate.

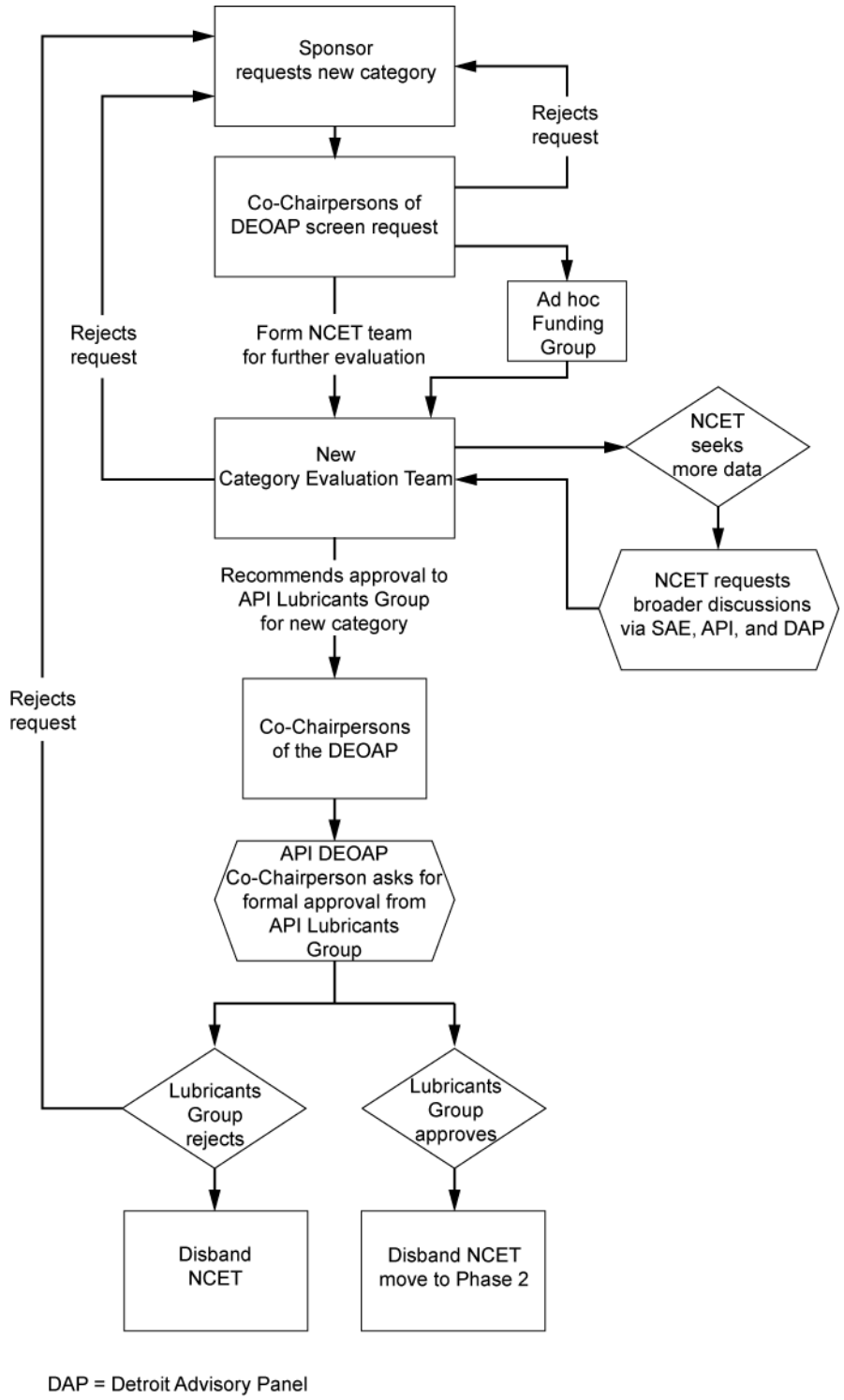


Figure D-2—Phase 1: Category Request/Evaluation

The NCET may solicit additional industry input and data at any time to assist it in reaching a decision. Any industry group [e.g., SAE, API Detroit Advisory Panel (DAP), and EMA] can be asked to provide supplemental information.

The NCET's specific charge is to evaluate the request and to make one of the decisions below:

a. Support the request for the new category and recommend to DEOAP that the request be forwarded to the API Lubricants Standards Group for consideration to proceed with category development. This recommendation shall identify the need for the category, recognize its feasibility, provide a timetable for

category development, suggest draft language for the category, and identify the proposed method for funding development of the new category. The API Co-Chairperson of the DEOAP shall present the DEOAP recommendation, along with appropriate documentation, to the API Lubricants Standards Group for consideration at its next meeting.

or

b. Deny the request, explaining to the sponsor in writing the reasons for the denial. The sponsor has the option of resubmitting the request with additional information.

or

c. Not reach consensus. If the NCET cannot reach consensus on the request for a new performance category, the API Co-Chairperson shall provide the API Lubricants Standards Group with the vote outcome and a summary of the reasons for the action.

D.3.1.3.2 API Lubricants Standards Group

The API Lubricants Standards Group must approve or deny the recommendation by formal vote. If denied, the API DEOAP Co-Chairperson will provide the sponsor with a written explanation outlining the Lubricants Standards Group's reasons for disapproval. The sponsor may then make a new request with modifications based on the Lubricants Standards Group actions.

If the API Lubricants Standards Group approves the NCET recommendation for the new category, the API DEOAP Co-Chairpersons will move the process forward, and development of the new category will commence. Independent of whether the Lubricants Standards Group approves or denies the request, the ad hoc NCET disbands at this point in the process.

D.3.2 Phase 2: Category Development

D.3.2.1 New Category Development Team (NCDT) Responsibilities

When the API Lubricants Standards Group approves the request for new category development, the API DEOAP Co-Chairpersons will convene an ad hoc New Category Development Team (NCDT) (see Figure D-3).

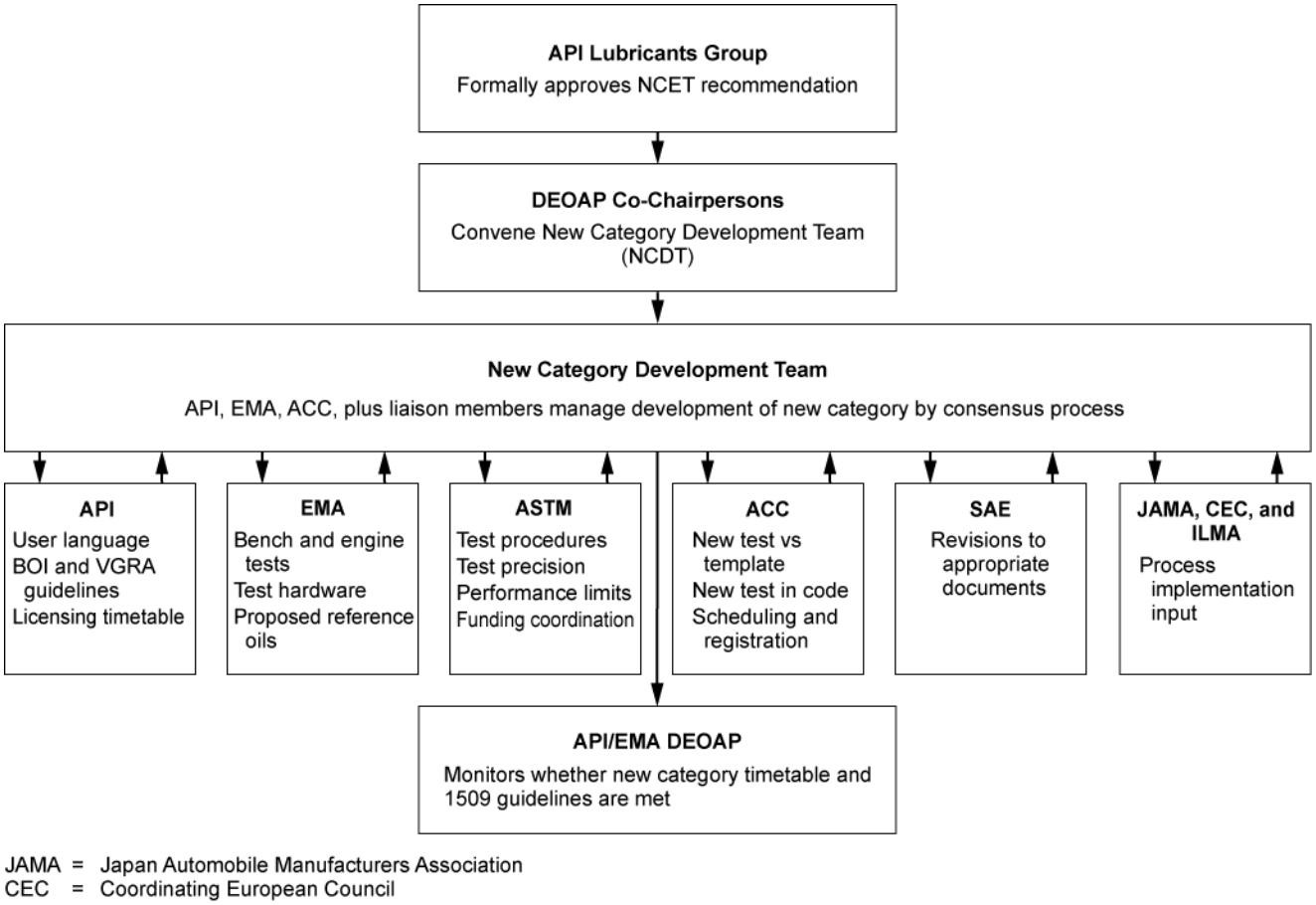
The NCDT will function under the same guidelines as the NCET (see D.3.1.3). However, the API, EMA, and ACC representatives need not be the same as those on the NCET. The NCDT will decide on working rules, select a chairperson or facilitator, and, as with the NCET, invite liaison representatives from other groups or affected parties: ASTM, SAE, ILMA, independent test laboratories, or others as required. Other national, regional, or international bodies—for example, JAMA—may also be asked for input during category implementation.

The DEOAP Co-Chairpersons will explain to the NCDT any conditions established by the Lubricants Standards Group, including, but not limited to, the following:

a. The proposed draft language for the category.
b. The proposed timetable.

The DEOAP Co-Chairpersons are responsible for ensuring that funding sources are established to cover the specific costs for all necessary category components. These components, which may include development of new engine and bench tests and precision matrix testing, are identified and confirmed during Phase 2 by the functional work groups: for example, ASTM and the NCDT, respectively. The DEOAP Co-Chairpersons will establish a new ad hoc funding Task Force or reconvene the Task Force used to arrive at the agreement in principle on funding (see D.3.1.3.1). The composition of this Task Force will be constituted in the same manner as the original one and function in a similar way.

The NCDT will manage and coordinate the new process working toward final approval within the timetable and budget. The Co-Chairpersons will monitor the process on behalf of the EMA and API Lubricants Standards Groups and periodically report on progress to them. In addition, the Co-Chairpersons will carry out any other liaison functions that are not covered by the responsibilities of the NCDT.



JAMA = Japan Automobile Manufacturers Association
CEC = Coordinating European Council

Figure D-3—Phase 2: Category Development

D.3.2.2 Specific Duties of NCDT

The NCDT will manage all phases of category development through four functional work groups chaired by NCDT members: an API member will manage the API function, an EMA member the EMA function, an ACC member the ACC function, and another NCDT member the ASTM and SAE functions.

D.3.2.2.1 API Function

a. Ensure that no conflicts develop between existing categories and the one proposed.
b. Coordinate with the API BOI/VGRA Task Force on its development of base oil interchange and viscosity-grade read-across guidelines based on data (including ASTM matrix testing), engineering judgment, and field experience.
    1. Ensure that matrix testing is conducted for the new engine tests in accordance with the plan developed by the NCET (see D.3.1.3.1) so that sufficient data is available to allow the establishment of appropriate BOI and VGRA guidelines simultaneous with the establishment of the category performance criteria.
    2. Review proposed BOI/VGRA guidelines with the NCDT before formal approval. These guidelines will be embodied in the new category request when it is forwarded to the API Lubricants Standards Group to consider for inclusion in API 1509.
c. Draft a timetable to enable licensing at the earliest practicable date. That timetable will indicate the dates at which first allowable licensing can occur for the new category. Normally, the first allowable licensing date for a new category is 1 year after ASTM Subcommittee B formally approves the new performance standard used to define the category. This delay allows all oil marketers equal opportunity to meet the category requirements.
d. Develop draft consumer user language. The final version of that language will be approved by the API Lubricants Standards Group and EMA Lubricants Committee.

e. Ensure that emergent marketing or consumer issues that arise during category development are brought to the attention of responsible groups for resolution.

D.3.2.2.2 EMA Function

a. Guide the selection process for appropriate reference oils as well as low and high discrimination oils. At least one reference oil must be identified that meets all the bench and engine tests contained in the new category. The oil shall be used in test development and reformulated as necessary to ensure the best measure of performance. Before any new minimum performance category can be established by ASTM, at least one reference oil must be able to meet all category requirements. This reference oil shall have been engine tested in accordance with the ACC Code of Practice.

   The new category sponsors or their designee will have the primary responsibility for recommending oil selections. The DEOAP will provide feedback and formally approve the selections, and the selections will be reviewed with ASTM.

Note: “Discrimination” oils should be available for each test. It is highly desirable that the minimum performance reference oil represent the performance level of the oil category being superseded and the high performance reference oil meet the expected performance level of the new category.

b. Recommend and/or provide relevant engine tests and hardware, with or without a test procedure.
c. Stay abreast of changes that may occur (government-, industry-, or consumer-generated) and, when necessary, suggest modifications to the new category to ensure that it will meet the predetermined target (see D.3.1.3.1). Coordinate any necessary modifications in language and tests with the NCDT.

D.3.2.2.3 ACC Function

a. Assess the new tests against the criteria of the ACC Code of Practice Template with the objective of optimizing cost-effective engine testing quality. Test precision and discrimination are examples of qualities to be assessed. Provide analysis of these assessments to the DEOAP and NCDT.
b. Incorporate the new engine tests that meet the Template into the ACC Code of Practice together with accompanying test scheduling and registration procedures.

D.3.2.2.4 ASTM and SAE Function

a. Work through ASTM Section D02.B0.02 Heavy-Duty Engine Oil Classification Panel to select or develop test methods that evaluate the needs defined by the NCET.
b. Ensure that the bench and/or engine tests selected for the new category will satisfy the requirements of the draft consumer language approved by the API Lubricants Standards Group. The NCDT and ASTM will also develop a timetable that contains, among other things, planned dates for reference oil selection, bench and engine test selection, and test method completion. Dates must agree with those approved by the Lubricants Standards Group (see D.3.2.1). Tests should correlate with field experience.
c. Provide input, as requested, to the new category sponsors in the selection of appropriate discrimination reference oils for the individual tests in the new proposed category (see D.3.2.2.2).
    1. Coordinate with other appropriate technical societies, such as SAE, to develop and approve written test procedures and limits for tests not within the ASTM system that will be published as standards and specifications.
    2. Once a test shows satisfactory discrimination of oil performance, conduct matrix testing to determine test precision and assess base oil and viscosity-grade effects. If, for example, an engine test is being developed by ASTM, it is ASTM’s responsibility to have a functioning task force or surveillance panel in place to coordinate activities and analyze test data. For bench tests, ASTM must provide a method for referencing and/or calibrating each bench test that does not have an assigned surveillance panel.
d. Implement and coordinate through the appropriate ASTM group the funding mechanism recommended by the NCET and approved by the API Lubricants Standards Group for the development of tests, precision, and base oil interchange. Also establish the high reference/“passing” category oil for the Test Monitoring Center.
e. Establish pass/fail limits for each test and the entire category.
f. Update SAE “J” documents as appropriate.

D.3.2.3 Category Completion

At or near the end of the development of the new category, the NCDT must undertake a number of actions to bring the process to a successful conclusion. In general, these actions are to review the output of the four functional groups and advise as necessary to ensure completion as well as harmony among the discrete parts. Specific actions are as follows:

a. For the ASTM functional group, review the appropriateness of the test data developed for discrimination and precision. Agree on the final description for each new performance test and that the optimum test methods and performance limits have been chosen. (At least one “demonstration” reference oil capable of meeting all minimum performance criteria is required.)
b. For the ACC functional group, ensure that the ACC Code includes each of the new engine performance tests.
c. Obtain from SAE and other cooperating agencies any standards, codes, and publications that are necessary parts of the new category.

When the NCDT is in agreement that all of its original goals and objectives have been met, the team will forward all procedures, facts, data, and information that is pertinent to the new category to the DEOAP. The DEOAP will promptly convene and together with the NCDT ensure that (1) the tests developed under NCDT guidance satisfy the need expressed by the original sponsor, (2) the performance targets contained in the proposed consumer language are met by the tests proposed for the category, (3) the timetable is acceptable, (4) and the test methods chosen to define the new standard represent the most cost-effective means of establishing the new performance level. All input is evaluated, including API BOI and VGRA guidelines. The complete package is then presented by the DEOAP Co-Chairpersons, with a recommendation for formal approval, to the API Lubricants Standards Group. API must approve the complete package including the final consumer language.

D.3.3 Phase 3: Category Implementation

D.3.3.1 Alternate Category Development Process

As stated in D.3.2.1, the Co-Chairpersons will monitor the category development process to ensure adherence to the timeline as well as other applicable API 1509 new category guidelines (see Figure D-4).

If unanticipated problems or situations arise that cannot be overcome and that unduly delay category development or prevent original plans from meeting expectations, EMA may choose to develop minimum performance requirements or a new category for API consideration through a process of their own choosing outside of the processes herein described. However, before this or any new minimum API performance category is adopted, it must be approved by the API Lubricants Standards Group at which time it may be incorporated into API 1509.

D.3.3.2 Normal Category Development Process

Upon agreement between the NCDT and DEOAP that all parameters of the new category that were approved by the API Lubricants Standards Group during the evaluation phase have been met (see D.3.2.3), the final approval procedure is implemented. However, if for some reason, full, complete approvals have not been obtained, the DEOAP will carry out the necessary negotiations to resolve differences.

When all differences are resolved, the final specification will include its API Category designation, a description of performance parameters, pass/fail limits, BOI and VGRA guidelines, ACC Code requirements, and consumer language. Timelines for licensing will also be designated by API.

After final approval is obtained, API staff will be responsible for issuing revisions to API 1509 and advising oil marketers and other affected parties of the new licensing standard.

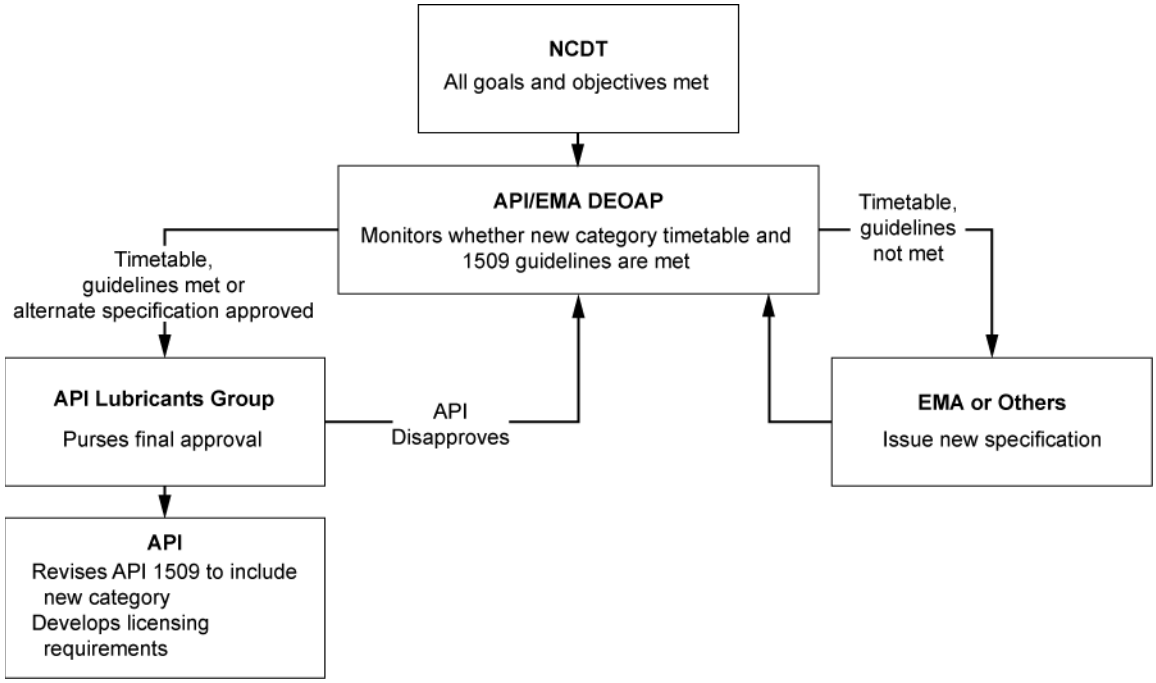


Figure D-4—Phase 3: Category Implementation

D.4 Supplement to Existing C Category

An individual, company, or association may propose to the DEOAP that a Supplement to an existing C Category be developed to meet an urgent field performance need. If developed and approved, this Supplement would be incorporated into API 1509 as a separate, licensable classification in the lower portion of the API Service Symbol "Donut." The Supplement would not replace the existing C Category; however, it would establish additional performance requirements beyond those originally approved for the Category. Oils licensed against the existing C Category specification would remain licensed.

Since the request for the Supplement results from an urgent field performance need, the development process is designed to move more quickly than the traditional C Category development process. This "fast track" process is managed by the DEOAP and is intended to minimize retesting and oil qualification time.

D.4.1 Supplement Evaluation

The DEOAP will formally evaluate each request for a Supplement to an existing C Category. Decision-making by consensus will be strongly encouraged. However, if that is not possible, decision-making will be assumed by API and EMA representatives through majority vote. In the case of a tie vote, DEOAP will continue to work to achieve a consensus but, if unable to do so, will refer the request to the API Lubricants Standards Group for resolution.

For a proposed C Category Supplement to move forward, DEOAP should consider the following items:

a. Tests must be developed and be ASTM-approved or have made significant progress toward ASTM approval.
b. Oils are being marketed that meet the proposed Supplement.
c. Multiple technologies have been shown to meet the proposed Supplement.
d. There is no previous Supplement for this category (one Supplement per Category).

The DEOAP will work to reach consensus positions on the following questions:

a. What is the proposed change and why is it required?
b. What field performance issues support the need for a Supplement?
c. Does data presented support the request?
d. When is it needed in the marketplace?
e. What are the potential impacts on engines and aftertreatment devices?

f. What are the potential impacts on consumers?
g. What are the potential impacts on the environment?
h. Can the tests requested for the Supplement be used for the next full, new C Category?
i. Are the requested performance tests available, or will they be available within the requested time frame, that properly evaluate the requested performance needs?
j. Do the perceived benefits outweigh the projected costs?

Note: Since a Supplement will rely heavily on engine manufacturer tests and/or performance specifications, EMA members will be responsible for determining and justifying the economics for development.

The DEOAP may solicit further industry input and data at any time to assist it in reaching a decision. Any industry group [e.g., SAE, API Detroit Advisory Panel (DAP), ACC and EMA] can be asked to provide additional information.

The DEOAP must decide to:

a. Support the request for the Supplement and forward it to the API Lubricants Standards Group for consideration to proceed with development. This recommendation shall identify the need for the Supplement to an existing Category, recognize its feasibility, provide a timetable for development, suggest draft language for the Supplement, and verify funding of the development. The API Co-Chairperson of the DEOAP shall present the DEOAP recommendation, along with appropriate documentation, to the API Lubricants Standards Group for consideration at its next meeting.

or

b. Deny the request, explaining to the sponsor in writing the reasons for the denial. The sponsor has the option of resubmitting the request with additional information. The API Co-Chairperson of the DEOAP shall report this denial to the API Lubricants Standards Group.

or

c. Not reach consensus. If the DEOAP cannot reach consensus on the request for a Supplement, the API Co-Chairperson shall provide the API Lubricants Standards Group with the vote outcome and a summary of the reasons for the action.

D.4.2 API Lubricants Standards Group

The API Lubricants Standards Group must approve or deny the recommendation for a Supplement by formal vote. If denied, the API DEOAP Co-Chairperson will provide the sponsor with a written explanation outlining the API Lubricants Standards Group's reasons for disapproval. The sponsor may then make a new request to the DEOAP with modifications based on the API Lubricants Standards Group actions.

If the API Lubricants Standards Group approves the DEOAP recommendation for the Supplement, the DEOAP Co-Chairpersons will proceed with development.

D.4.3 Supplement Development

When the API Lubricants Standards Group approves the request for development of a C Category Supplement, the DEOAP will follow the Fast-Track process outlined on Figure D-5. A comparison of the fast track supplement process and the normal C Category process is shown on Table D-1 for guidance.

The DEOAP Co-Chairpersons will explain any conditions established by the Lubricants Standards Group, including, but not limited to, the following:

a. The proposed draft language for the Supplement.
b. The proposed timetable.

Development of a Supplement will be fast-tracked by relying on the following principals:

a. Performance requirements will be based primarily on tests developed by Original Equipment Manufacturer (OEM) sponsors.
b. Oils meeting the Supplement must maintain the performance criteria of the corresponding C Category.
c. Oils licensed by API for the Supplement must also be licensed for the corresponding C Category.
d. The ASTM HDEOCP, or the appropriate Surveillance Panel or Test Development Task Force, must deem engine tests as suitable for use in the Supplement, and the tests must be monitored by TMC.

e. Engine tests must be run in ASTM-calibrated stands and meet performance limits and read-across guidelines established by the OEM test sponsor OR applicable engine test results must be reviewed by the test sponsor and deemed acceptable (see Section D.5 regarding OEM review).

D.4.4 Association Functions—Category Supplement

D.4.4.1 OEM Test Sponsor

The OEM sponsoring each individual test shall fulfill the following requirements:

a. Justify the need for the test and performance limits.
b. Provide test hardware.
c. Provide a test procedure.
d. Provide discrimination and precision data.
e. Provide suggested initial BOI and VGRA guidelines.
f. Provide suggested pass/fail limits.

D.4.4.2 API

API shall fulfill the following requirements:

a. Ensure that no conflicts develop between existing Categories and the proposed new Supplement.
b. For the Supplement, ensure that the test sponsor provides sufficient input to allow adoption of appropriate BOI and VGRA Guidelines simultaneous with the establishment of the Supplement performance criteria. Coordinate these activities with the API BOI/VGRA Task Force.
c. Draft a timetable to enable Supplement licensing at the earliest practicable date. This timetable will indicate the dates at which first allowable licensing can occur. Supplement requests will generally be approved based on a more urgent need for enhanced performance in the field. Therefore, every effort will be made to license use of a Supplement classification at the earliest possible date, after the performance tests are accepted for use and limits are defined.
d. Develop draft Consumer User Language. The final version of that language will be approved by the API Lubricants Standards Group and EMA Lubricants Committee.
e. Ensure that emergent marketing or consumer issues that arise during development of a Category Supplement are brought to the attention of responsible groups for resolution.

D.4.4.3 EMA

EMA shall fulfill the following requirements:

a. Recommend the combination of engine and bench tests to define the Supplement.
b. Establish the engine and bench test limits.
c. Guide the selection process for appropriate reference oils as well as low and high discrimination oils.
    1. Since a Supplement incorporates new tests from engine builder specifications, the sponsor of the test must identify reference oils that demonstrate that performance differentiation can be achieved. The sponsor should also provide information illustrating that passing a new test is sufficient to meet the performance criteria of the existing C Category upon which the Supplement is based.
    2. The new Supplement sponsors or their designees will have the primary responsibility for recommending oil selections. The DEOAP will provide feedback and formally approve the selections, and the selections will be reviewed with ASTM.

Note: “Discrimination” oils should be available for each test. It is mandatory that the minimum performance discrimination oil meet the performance level of the oil Category being superseded and the high performance discrimination oil meet the expected performance level of the new Supplement.

d. Recommend and/or provide relevant engine tests and hardware, with or without a test procedure.

Note: Test procedures must be provided for fast-tracking development of a new Supplement.

D.4.4.4 ACC

ACC shall fulfill the following requirements:

a. Assess any new tests against the criteria of the ACC Code of Practice Template with the objective of optimizing cost-effective engine testing quality. Test precision and discrimination are examples of qualities to be assessed. Provide analysis of these assessments to the DEOAP.
b. Consider incorporating the new engine tests that meet the Template into the ACC Code together with accompanying test scheduling and registration procedures.

D.4.4.5 ASTM and SAE

ASTM and SAE shall fulfill the following requirements:

a. Ensure that the engine and/or bench tests selected for the new Supplement will satisfy the requirements of the draft consumer language approved by the API Lubricants Standards Group. Dates indicated must agree with those approved by the API Lubricants Standards Group (see D.4.2). Tests should correlate with field experience.
b. Provide input, as requested, to the new Supplement sponsors in the selection of appropriate discrimination reference oils for the individual tests in the new proposed Supplement (see D.4.4.3).
    1. ASTM will coordinate with other appropriate technical societies, such as SAE, to develop and approve written test procedures and limits for tests not within the ASTM system that will be published as standards and specifications.
    2. It is ASTM's responsibility to have a functioning Development Task Force or Surveillance Panel in place to coordinate activities and analyze test data. For bench tests that do not have an assigned Surveillance Panel, ASTM must provide referencing and/or calibration methods
c. Update SAE "J" documents as appropriate.

D.4.5 Supplement Completion

D.4.5.1 Category Supplement

When the DEOAP is in agreement that all of its original goals and objectives have been met, the DEOAP will promptly convene to ensure that (1) the tests involved satisfy the needs expressed by the original sponsor, (2) the performance targets contained in the proposed consumer language are met by the tests proposed for the Supplement, (3) the timetable is acceptable, (4) and the test methods chosen to define the new Supplement represent the most cost-effective means of establishing the new performance level. All input is evaluated, including API BOI and VGRA Guidelines. The DEOAP will carry out the above functions to the extent possible, considering the fast-track process used to develop the Supplement.

D.4.5.2 API Lubricants Standards Group Approval

The complete package describing a new C Category Supplement is then presented by the DEOAP Co-Chairpersons, with a recommendation for formal approval, to the API Lubricants Standards Group. The API Lubricants Standards Group must approve by letter ballot the complete package including the final consumer language. If the API Lubricants Standards Group does not approve the C Category Supplement package, they must send it back to the DEOAP indicating changes necessary for approval or reasons for an outright rejection.

D.4.6 Category Supplement Implementation

Upon agreement between the DEOAP members that all parameters of the new Category Supplement that were approved by the API Lubricants Standards Group during the evaluation phase have been met, the final approval procedure is implemented. However, if for some reason, full, complete approvals have not been obtained, the DEOAP will carry out the necessary negotiations to resolve differences.

When all differences are resolved, the final specification will include its API Category Supplement Classification, a description of performance parameters, pass/fail limits, BOI and VGRA Guidelines, ACC Code requirements, and consumer language. Timelines for licensing will also be designated by API.

If, during this step, the DEOAP makes any changes to the package approved by the API Lubricants Standards Group, these changes must be presented by the DEOAP API Co-Chairperson to the API Lubricants Standards Group for final approval.

After final approval is obtained, API staff will be responsible for issuing revisions to API 1509 and advising oil marketers and other affected parties of the new licensing standard.

D.5 Supplement Performance Requirements and Documentation

It is expected that the performance tests and limits for a new Supplement will be listed in applicable industry documents, such as ASTM D4485. However, since a Supplement is developed with a fast-track process to meet an urgent technical need and with an expedited time to first license, it is important that the performance needs and limits for an active Supplement are incorporated into API 1509 as soon as possible.

D.5.1 Active Supplement Requirements

The performance requirements and test limits for an approved Supplement are outlined in Annex S of API 1509. CI-4 PLUS is the only active C Category Supplement for which an API license can be issued as of September 1, 2004.

D.5.2 Supplement Performance Certification

A marketer that wants to license an oil against the Supplement requirements must attest in the API EOLCS Online Application that the product meets the requirements of the Supplement and its associated C Category. For the C Category, this means following the traditional process for licensing the oil with API (i.e., the marketer attests that the product has been tested in accordance with and met all applicable requirements for the Category as defined in API 1509, the ACC Code, SAE J300, and ASTM D4485).

For the Supplement, the marketer must meet the specific performance requirements approved by the DEOAP and the API Lubricants Standards Group. However, the fast-track process also allows marketers to apply technical judgment in lieu of candidate engine test results. If technical judgment is applied, it must be documented in one of two ways in cooperation with the OEM test sponsor:

a. Formal OEM approval (e.g., oil is listed on an OEM approval list or an OEM approval letter has been issued for the oil).
b. Confirmation of OEM review. If this method is used, the marketer must indicate in the EOLCS Online Application that the OEM has reviewed the pertinent data and agreed the product meets the requirements of the Supplement. The marketer must submit a Part F signed by the OEM and marketer confirming the review occurred.

Note: The OEM approval or review process must involve a detailed summary and discussion of results from the specific engine test type in question. These data, which should be on similar and related oil formulations or from a Single Technology Matrix (STM), will be used to support the oil marketer's position that the oil being licensed is capable of meeting the performance requirements.

When requested by API, marketers that choose to use the Supplemental Performance certification process must provide copies of any approval letters to API along with the technical data and information that was used to justify the use of this process.

API may require marketers to provide additional technical data, engine test results, or documentation at any time if API believes that additional data is needed to establish the performance of specific oil formulations. Marketers remain responsible for ensuring and warranting that all products that are licensed and marketed pursuant to the streamlined process will satisfy and meet all of the specified performance criteria. If a marketer has reason to believe that a specific product or formulation does not satisfy all of the performance criteria, the marketer must immediately notify API.

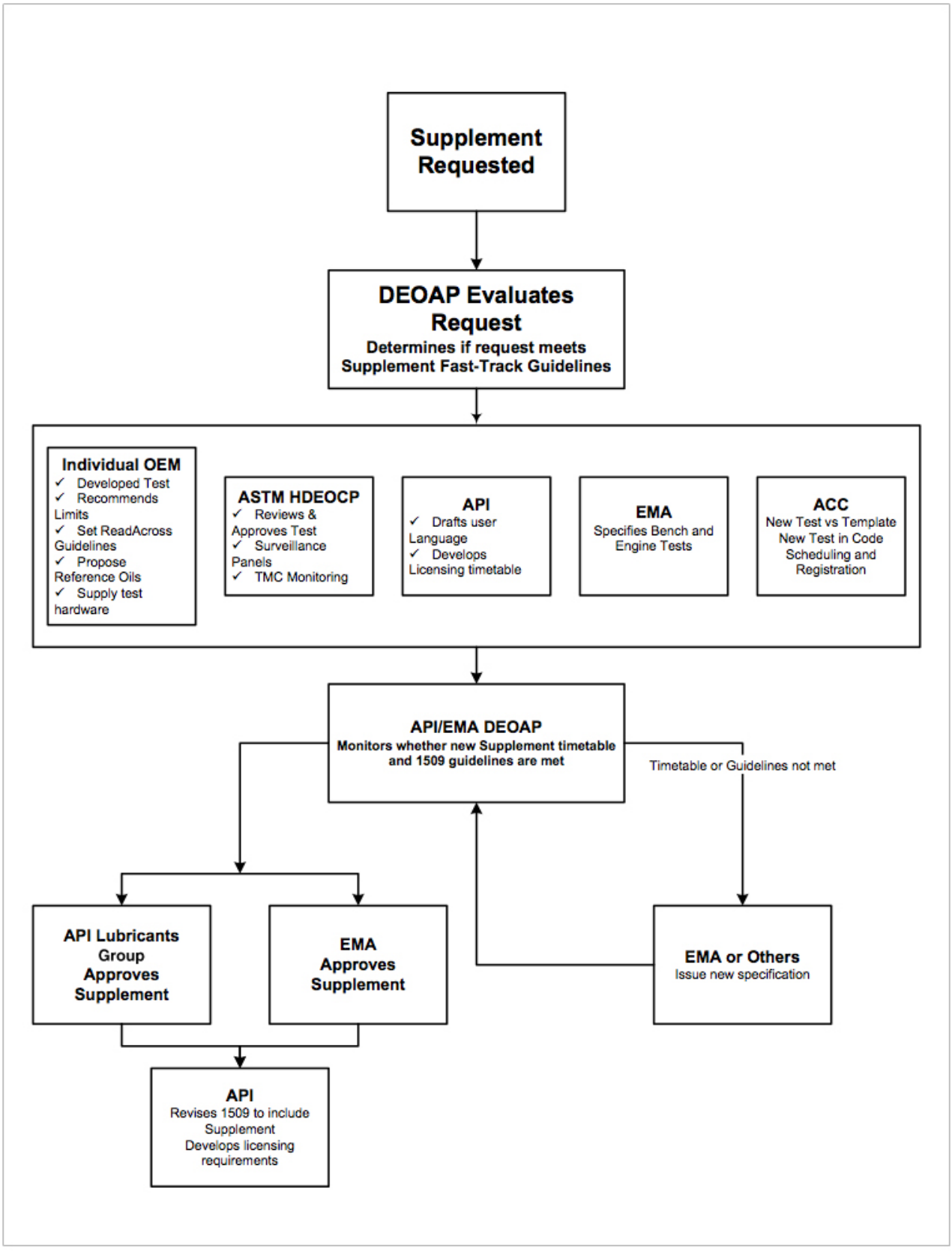


Figure D-5—Heavy Duty Category Supplement Request/Approval Process Fast Track Approach

Table D-1—Comparison of Fast Track Supplement and Normal C Category Development Processes

Process/Subprocess	Category	Supplement
Specification		
Establish need	NCET	DEOAP
Tests	EMA	Individual OEMs
Timeline management	NCDT/ASTM	DEOAP
Test Development		
Hardware selection	OEMs	OEMs
Initial procedure	OEMs	OEMs
Final procedure	ASTM	OEMs
Precision data	ASTM	OEMs
Discrimination data	OEMs	OEMs
Research report	ASTM	ASTM
Template evaluation	ACC	ACC
Monitoring	ASTM	ASTM
Reference oils	OEMs	OEMs
Testing protocol	ACC	ASTM approved
Product Approval		
Testing required	ASTM	DEOAP
Limits	EMA/API	OEMs
BOI/VGRA	API	OEM/API
Latest pre-licensed C category		API
Accept test development data		API
Formulation modifications	ACC	ACC
Licensing	API	API
Aftermarket Auditing	API	API

Annex E

API Base Oil Interchangeability Guidelines for Passenger Car Engine Oils and Diesel Engine Oils

The most recent version of Annex E can be downloaded from API's website at www.api.org.

To receive a copy of Annex E by mail, please contact:

Global Industry Services/EOLCS
American Petroleum Institute
1220 L Street, N.W.
Washington, D.C. 20005
Telephone: 202-682-8516 or
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Facsimile: 202-962-4739
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Annex F

API Guidelines for SAE Viscosity-Grade Engine Testing

The most recent version of Annex F can be downloaded from API's website at www.api.org.

To receive a copy of Annex F by mail, please contact:

Global Industry Services/EOLCS
American Petroleum Institute
1220 L Street, N.W.
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Annex G

Requirements for API Service Categories ~~SH~~, SJ, SL, SM, SN, SP by Viscosity Grade

~~Table G-1—Requirements for API Service Category SH by Viscosity Grade~~

~~Engine Test Requirements[a]—All Viscosity Grades~~			
~~Sequence IID~~	~~Pass~~		
~~Sequence IIIE~~	~~Pass~~		
~~Sequence VE~~	~~Pass~~		
~~L-38~~	~~Pass~~		
~~ASTM D6593 (Sequence VG)[b]~~	~~Viscosity Grade Performance Criteria[b]~~		
~~Average engine sludge, merits~~			
~~Average rocker cover sludge, merits~~			
~~Average engine varnish, merits~~			
~~Average piston skirt varnish, merits~~			
~~Oil screen sludge, % area~~			
~~Oil screen debris, % area~~			
~~Hot-stuck compression rings~~			
~~Cold-stuck rings~~			
~~Oil ring clogging, % area~~			
~~ASTM D7589 (Sequence VID)[c]~~			
~~SAE XW-16 viscosity grade~~			
~~FEI SUM~~			
~~FEI 2~~			
	~~SAE 5W-30~~	~~SAE 10W-30~~	~~SAE 15W-40~~
~~SAE XW-20 viscosity grade~~			
~~FEI SUM~~			
~~FEI 2~~			
~~SAE XW-30 viscosity grade~~			
~~FEI SUM~~			
~~FEI 2~~			
~~SAE 10W-30 and all other viscosity grades not listed above~~			
~~FEI SUM~~			
~~FEI 2~~			
~~ASTM D6709 (Sequence VIII)~~			
~~Bearing weight loss, mg~~	~~25~~	~~20~~	~~18~~
~~ASTM D2887 volatility loss at 371°C (700°F), % max[e]~~	~~20~~	~~17~~	~~15~~
~~ASTM D6795, % flow reduction, max~~	~~50~~	~~50~~	~~NR~~
~~ASTM D4951 or D5185, phosphorus % mass, max~~	~~0.12~~	~~0.12~~	~~NR~~
~~ASTM D92 flash point, °C, min[d]~~	~~200~~	~~205~~	~~215~~
~~ASTM D93 flash point, °C, min[d]~~	~~185~~	~~190~~	~~200~~
~~ASTM D892 foaming tendency (Option A)~~			
~~Sequence I, max, foaming/settling[e]~~	~~10/0~~	~~10/0~~	~~10/0~~
~~Sequence II, max, foaming/settling[e]~~	~~50/0~~	~~50/0~~	~~50/0~~
~~Sequence III, max, foaming/settling[e]~~	~~10/0~~	~~10/0~~	~~10/0~~
~~ASTM D6082[f]~~	~~Report~~	~~Report~~	~~Report~~

ASTM D6922, homogeneity and miscibility	g	g	g
L-38 shear stability	h	h	h

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.
[a]Tests and limits are per ASTM D4485.
[b]There are no bench test and measured parameter requirements for other viscosity grades.
[c]A passing volatility result in only one of these procedures is required.
[d]Either Test Method D92 or Test Method D93 flash point requirement shall be met.
[e]Settling volume determined at 5 min.
[f]Kinetic foam volume; mL/static foam volume and mL/collapse time in seconds.
[g]Homogeneous with SAE reference oils.
[h]10-hour stripped kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥5.6 mm^2/s.

Table G-1—Requirements for API Service Category SJ by Viscosity Grade

Engine Test Requirements[a]—All Viscosity Grades	
ASTM D5844 (Sequence IID)	
Average engine rust rating	8.5 (min)
Number stuck lifters	None
Or	
ASTM D6557[b] (Ball Rust Test)	
Average gray value	100 (min)
ASTM D5533 (Sequence IIIE)	
Hours to 375% kinematic viscosity increase at 40°C	64 (min)
Average engine sludge rating	9.2 (min)
Average piston skirt varnish rating	8.9 (min)
Average oil ring land deposit rating	3.5 (min)
Lifter sticking	None
Scuffing and wear	
Cam or lifter scuffing	None
Cam plus lifter wear, mm	
Average	30 (max)
Maximum	64 (max)
Ring sticking (oil-related)	None
Or	
ASTM D6984 (Sequence IIIF)	
Kinematic viscosity, % increase at 40°C	325 (max)
Average piston skirt varnish rating	8.5 (min)
Weighted piston deposit rating	3.2 (min)
Screened average cam-plus-lifter wear, mm	20 (max)
Hot stuck rings	None
Or	
ASTM D7320 (Sequence IIIG)	
Kinematic viscosity, % increase at 40°C	150 (max)
Weighted piston deposit rating	3.5 (min)
Cam-plus-lifter wear average, µm	60 (max)
Hot stuck rings	None
Or	
ASTM D8111 (Sequence IIIH 60/70-Hour Guideline)	
60 kinematic viscosity, % increase at 40°C	307 (max)
70 average weighted piston deposits, merits	2.5 (min)
70 average piston skirt varnish, merits	7.5 (min)
ASTM D5302 (Sequence VE)	
Average engine sludge rating	9.0 (min)
Rocker arm cover sludge rating	7.0 (min)
Average piston skirt varnish rating	6.5 (min)
Average engine varnish rating	5.0 (min)
Oil ring clogging, %	Report
Oil screen clogging, %	20.0 (max)
Compression ring sticking (hot stuck)	None
Cam wear, mm	
Average	127 (max)
Maximum	380 (max)
Or	
ASTM D6891 (Sequence IVA) plus ASTM D6593 (Sequence VG[b])	
Average cam wear, µm	120
Average engine sludge rating	7.8 (min)
Rocker arm cover sludge rating	8.0 (min)
Average piston skirt varnish rating	7.5 (min)
Average engine varnish rating	8.9 (min)

Oil screen clogging, %	20 (max)
Hot stuck compression rings	None
Or	
ASTM D6891 (Sequence IVA) plus ASTM DXXXX (Sequence VH)	
Average engine sludge, merits	7.4 (min)
Average rocker cover sludge, merits	7.4 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.4 (min)
Oil screen clogging, % area	Rate & report
Hot stuck compression rings	None
ASTM D5119 (L-38)	
Bearing weight loss, mg	40 (max)
Shear stability	[c]
Or	
ASTM D6709 (Sequence VIII)	
Bearing weight loss, mg	26.4 (max)
Shear stability	[c]

Bench Test and Measured Parameter[a]	Viscosity Grade Performance Criteria	
	SAE 0W-20, SAE 5W-20, SAE 5W-30, SAE 10W-30	All Others[d]
ASTM D5800 volatility loss, % max[e]	22	20[f]
ASTM D6417 volatility loss at 371°C (700°F), % max[e]	17	15[e]
ASTM D5480 volatility loss at 371°C (700°F), % max[e]	17	15[f]
ASTM D6795, % flow reduction, max	50	50
ASTM D6794, % flow reduction, max	Report	Report
With 0.6% H_2O	Report	Report
With 1.0 % H_2O	Report	Report
With 2.0% H_2O	Report	Report
With 3.0% H_2O	Report	Report
ASTM D4951 or D5185 phosphorus % mass, max	0.10[g]	NR
ASTM D92 flash point, °C min[h]	200	NR
ASTM D93 flash point, °C min[h]	185	NR
ASTM D892 foaming tendency (Option A)		
Sequence I, max, foaming/settling[i]	10/0	10/0
Sequence II, max, foaming/settling[i]	50/0	50/0
Sequence III, max, foaming/settling[i]	10/0	10/0
ASTM D6082 (optional blending required), static foam max, tendency/stability	200/50[j]	200/50[j]
ASTM D6922, homogeneity and miscibility	[k]	[k]

L-38 or Sequence VIII shear stability	I	I
ASTM D6335 high temperature deposits (TEOST), deposit wt, mg, max	60	60
ASTM D5133 gelation index, max[b]	12	NR
ASTM D4683, D4741, or D5481, High Temp/High Shear Viscosity @ 150°C, mPa·s, min	NR	2.6

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.
[a]Tests and limits are per ASTM D4485.
[b]If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the “S” category and there is no API Certification Mark, the Sequence VG (ASTM D6593), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.
[c]Ten-hour stripped kinematic viscosity (oil shall remain in original viscosity grade).
[d]Does not include SAE 0W-16 and 5W-16.
[e]Volatility requirement shall be met in either Test Method D5800, Test Method D 5480, or Test Method D6417. A passing result in only one of these procedures is required.
[f]Passing volatility loss performance only required for SAE 15W-40 oils.
[g]This is a non-critical specification as described in ASTM D3244.
[h]Either Test Method D92 or Test Method D93 flash point requirement shall be met.
[i]Settling volume determined at 10 min.
[j]Settling volume determined at 1 min.
[k]Homogeneous with SAE Reference Oils.
[l]Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥5.6 mm²/s.

Table G-2—Requirements for API Service Category SL by Viscosity Grade

Engine Test Requirements[a]—All Viscosity Grades	
ASTM D6984 (Sequence IIIF)	
Kinematic viscosity, % increase at 40°C	275 (max)
Average piston skirt varnish rating	9.0 (min)
Weighted piston deposit rating	4.0 (min)
Screened average cam-plus-lifter wear, mm	20 (max)
Hot stuck rings	None
Low temperature viscosity performance	Report
Or	
ASTM D7320 (Sequence IIIG)	
Kinematic viscosity, % increase at 40°C	150 (max)
Weighted piston deposit rating	3.5 (min)
Cam-plus-lifter wear average, µm	60 (max)
Hot stuck rings	None
Low temperature viscosity performance	Report
Or	
ASTM D8111 (Sequence IIIH 70-Hour Guideline)	
70 kinematic viscosity, % increase at 40°C	181 (max)
70 average weighted piston deposits, merits	3.3 (min)
70 average piston skirt varnish, merits	7.9 (min)
ASTM D6891 (Sequence IVA)	
Average cam wear (7 position avg.), µm	120 (max)
ASTM D5302 (Sequence VE)[b]	
Average cam wear, µm	127 (max)
Cam wear, µm	380 (max)
ASTM D6593 (Sequence VG[c])	
Average engine sludge rating	7.8 (min)
Rocker arm cover sludge rating	8.0 (min)
Average piston skirt varnish rating	7.5 (min)
Average engine varnish rating	8.9 (min)
Oil screen clogging, %	20 (max)
Hot stuck compression rings	None
Cold stuck rings	Report
Oil screen debris, %	Report
Oil ring clogging, %	Report
Or	
ASTM DXXXX (Sequence VH)	
Average engine sludge, merits	7.4 (min)
Average rocker cover sludge, merits	7.4 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.4 (min)
Oil screen clogging, % area	Rate & report
Hot stuck compression rings	None
ASTM D6709 (Sequence VIII)	
Bearing weight loss, mg	26.4 (max)
Shear stability	[d]

Bench Test and Measured Parameter[a]	Viscosity Grade Performance Criteria	
	SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W-30	All Others[d]
ASTM D6557 (Ball Rust Test), avg. gray value, min[b]	100	100
ASTM D5800 volatility loss, % max	15	15
ASTM D6417 volatility loss at 371°C (700°F), % max	10	10
ASTM D6795, % flow reduction, max	50	50
ASTM D6794, % flow reduction, max		
With 0.6% H_2O	50	50
With 1.0 % H_2O	50	50
With 2.0% H_2O	50	50
With 3.0% H_2O	50	50
ASTM D4951 or D5185 phosphorus % mass, Max[e]	0.10[f]	NR
ASTM D892 foaming tendency (Option A)		
Sequence I, max, foaming/settling[g]	10/0	10/0
Sequence II, max, foaming/settling[g]	50/0	50/0
Sequence III, max, foaming/settling[g]	10/0	10/0
ASTM D6082 (optional blending required), static foam max, tendency/stability[h]	100/0	100/0
ASTM D6922, homogeneity and miscibility	i	i
Sequence VIII shear stability	j	j
ASTM D7097, high temperature deposits (TEOST MHT), deposit wt, mg, max	45	45
ASTM D5133 gelation index, max[b]	12[k]	NR
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150°C, mPa·s, min	NR	2.6

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.

[a]Tests and limits are per ASTM D4485.

[b]Not required for oils containing a minimum of 0.08 % mass phosphorus in the form of ZDDP.

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

[d]Does not include SAE 0W-16 and 5W-16.

[e]For all viscosity grades: If CH-4, CI-4, and CJ-4 categories precede the “S” category and there is no API Certification Mark, the limit for phosphorus does not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils. This footnote cannot be applied if CK-4 or FA-4 is also claimed. Note that these 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.

[f]This is a non-critical specification as described in ASTM D3244.

[g]Settling volume determined at 10 min.

[h]Settling volume determined at 1 min.
[i]Homogeneous with SAE Reference Oils.
[j]Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥5.6 mm^2/s.
[k]For gelation temperatures at or above the W-grade pumpability temperatures as defined in SAE J300.

Table G-3—Requirements for API Service Category SM

Engine Test Requirements[a]	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W-30	All Others[b]
ASTM D7320 (Sequence IIIG)		
Kinematic viscosity increase @ 40°C, %	150 (max)	150 (max)
Average weighted piston deposits, merits	3.5 (min)	3.5 (min)
Hot stuck rings	None	None
Average cam plus lifter wear, µm	60 (max)	60 (max)
Or		
ASTM D8111 (Sequence IIIH)		
Kinematic viscosity increase @ 40°C, %	150 (max)	150 (max)
Average weighted piston deposits, merits	3.2 (min)	3.2 (min)
Hot stuck rings	None	None
ASTM D4684 (Sequence IIIGA), ASTM D8111 (Sequence IIIHA), or ASTM D7528 (ROBO)		
Evaluate EOT oil from ASTM Sequence IIIGA, Sequence IIIHA, or ROBO test with ASTM D4684 (MRV TP-1)	ASTM D4684 viscosity of EOT sample must meet requirements of original grade or next higher grade	NR
ASTM D6891 (Sequence IVA)		
Average cam wear (7 position avg.), µm	90 (max)	90 (max)
ASTM D6593 (Sequence VG)[c]		
Average engine sludge, merits	7.8 (min)	7.8 (min)
Average rocker cover sludge, merits	8.0 (min)	8.0 (min)
Average engine varnish, merits	8.9 (min)	8.9 (min)
Average piston skirt varnish, merits	7.5 (min)	7.5 (min)
Oil screen sludge, % area	20 (max)	20 (max)
Oil screen debris, % area	Rate & report	Rate & report
Hot-stuck compression rings	None	None
Cold stuck rings	Rate & report	Rate & report
Oil ring clogging, % area	Rate & report	Rate & report
Follower pin wear, cyl #8, avg, µm	Rate & report[d]	Rate & report[d]
Ring gap increase, cyl #1 and #8, avg, µm	Rate & report[d]	Rate & report[d]
Or		
ASTM DXXXX (Sequence VH)		
Average engine sludge, merits	7.4	7.4
Average rocker cover sludge, merits	7.4	7.4
Average engine varnish, merits	8.6	8.6
Average piston skirt varnish, merits	7.6	7.6
Oil screen clogging, % area	Rate & report	Rate & report
Hot stuck compression rings	None	None
ASTM D6709 (Sequence VIII)		
Bearing weight loss, mg	26 (max)	26 (max)

Bench Test and Measured Parameter[a]	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W-30	All Others[b]
ASTM D6557 (Ball Rust Test), avg. gray value, min[c]	100	100
ASTM D5800, evaporation loss, 1 hour at 250°C, % max[e]	15	15
ASTM D6417, simulated distillation at 371°C, % max	10	10
ASTM D6795, EOFT, % flow reduction, max	50	50
ASTM D6794, EOWTT, % flow reduction, max		
with 0.6% H_2O	50	50
with 1.0% H_2O	50	50
with 2.0% H_2O	50	50
with 3.0% H_2O	50	50
ASTM D4951 or D5185, phosphorus % mass, ma[f]	0.08[f]	NR
ASTM D4951 or D5185, phosphorus % mass, min[f]	0.06[g]	0.06[g]
ASTM D4951, D5185, or D2622, sulfur % mass, max[f]		
SAE 0W-20, 0W-30, 5W-20, and 5W-30	0.5[g]	NR
SAE 10W-30	0.7[g]	NR
ASTM D892 (Option A), foaming tendency		
Sequence I, mL, max, tendency/stability[h]	10/0	10/0
Sequence II, mL, max, tendency/stability[h]	50/0	50/0
Sequence III, mL, max, tendency/stability[h]	10/0	10/0
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability[i]	100/0	100/0
ASTM D6922, homogeneity and miscibility	j	j
ASTM D6709, (Sequence VIII) shear stability	k	k
ASTM D7097, TEOST MHT, high temperature deposits, deposit wt, mg, max[f]	35	45
ASTM D5133, gelation index, max[c]	12[l]	NR
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150°C, mPa·s, min	NR	2.6

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.
[a]Tests and limits are per ASTM D4485.
[b]Does not include SAE 0W-16 and 5W-16.
[c]If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the “S” category and there is no API Certification Mark, the Sequence VG (ASTM D6593), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.
[d]ASTM Surveillance Panel will review statistics annually.
[e]Calculated conversions specified in ASTM D5800 are allowed.
[f]For all viscosity grades: If CH-4, CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the “S” category limits for phosphorus, sulfur, and the TEOST MHT do not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils. This footnote cannot be applied if CK-4 or FA-4 is also claimed. Note that these “C” category oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.
[g]This is a non-critical specification as described in ASTM D3244.
[h]After 10-minute settling period.

[i]After 1-minute settling period.
[j]Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.
[k]Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥5.6 mm²/s.
[l]To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

Table G-4—Requirements for API Service Category SN, API SN with Resource Conserving, and API SN with SN PLUS

	API SN	API SN	API SN with Resource Conserving
	SAE 0W-16, SAE 5W-16, SAE 0W-20, SAE 5W-20, SAE 0W-30, SAE 5W-30, SAE 10W-30	Other Viscosity Grades	All Viscosity Grades[a]
Engine Test Requirements[a]			
ASTM D7320 (Sequence IIIG)			
Kinematic viscosity increase @ 40°C, %	150 (max)	150 (max)	150 (max)
Average weighted piston deposits, merits	4.0 (min)	4.0 (min)	4.0 (min)
Hot stuck rings	None	None	None
Average cam plus lifter wear, µm	60 (max)	60 (max)	60 (max)
Or			
ASTM D8111 (Sequence IIIH)			
Kinematic viscosity increase @ 40°C, %	150 (max)	150 (max)	150 (max)
Average weighted piston deposits, merits	3.7 (min)	3.7 (min)	3.7 (min)
Hot stuck rings	None	None	None
ASTM D6891 (Sequence IVA)			
Average cam wear (7 position avg), µm	90 (max)	90 (max)	90 (max)
ASTM D6593 (Sequence VG)[b]			
Average engine sludge, merits	8.0 (min)	8.0 (min)	8.0 (min)
Average rocker cover sludge, merits	8.3 (min)	8.3 (min)	8.3 (min)
Average engine varnish, merits	8.9 (min)	8.9 (min)	8.9 (min)
Average piston skirt varnish, merits	7.5 (min)	7.5 (min)	7.5 (min)
Oil screen sludge, % area	15 (max)	15 (max)	15 (max)
Oil screen debris, % area	Rate & report	Rate & report	Rate & report
Hot-stuck compression rings	None	None	None
Cold stuck rings	Rate & report	Rate & report	Rate & report
Oil ring clogging, % area	Rate & report	Rate & report	Rate & Report
Or			
ASTM DXXXX (Sequence VH)			
Average engine sludge, merits	7.6 (min)	7.6 (min)	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)	7.7 (min)	7.7 (min)
Average engine varnish, merits	8.6 (min)	8.6 (min)	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)	7.6 (min)	7.6 (min)
Oil screen clogging, % area	Rate & report	Rate & report	Rate & report
Hot stuck compression rings	None	None	None
ASTM D7589 (Sequence VID)[c]			
SAE XW-16 viscosity grade			
FEI SUM	NR	NR	2.8% min
FEI 2			1.3% min after 100 hours aging
SAE XW-20 viscosity grade			
FEI SUM			2.6% min
FEI 2			1.2% min after 100 hours aging
SAE XW-30 viscosity grade			
FEI SUM			1.9% min
FEI 2			0.9% min after 100 hours aging
SAE 10W-30 and all other viscosity grades not listed above			
FEI SUM			1.5% min
FEI 2			0.6% min after 100 hours aging

ASTM D8114 (Sequence VIE)[c]			
SAE XW-20 viscosity grade			
FEI SUM			3.2% min
FEI 2			1.5% min after 100 hours aging
SAE XW-30 viscosity grade			
FEI SUM			2.5% min
FEI 2			1.2% min after 100 hours aging
SAE 10W-30 and all other viscosity grades not listed above			
FEI SUM			2.2% min
FEI 2			1.0% min after 100 hours aging
ASTM D8226 (Sequence VIF)			
SAE XW-16 viscosity grade			
FEI SUM			3.7% min
FEI 2			1.8% min after 100 hours aging
ASTM D6709 (Sequence VIII)			
Bearing weight loss, mg	26 (max)	26 (max)	26 (max)
ASTM DXXXX (Sequence IX)[d]			
Average number of events	5 (max) [d]	5 (max) [d]	5 (max) [d]

Bench Test and Measured Parameter[a]	
Aged oil low-temperature viscosity	
ASTM D7320, (Sequence IIIGA), aged oil low-temperature viscosity[e]	a) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at MRV temperature specified in SAE J300 for original viscosity grade. b) If CCS viscosity measured is higher than maximum viscosity specified for original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade). c) EOT IIIGA sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in a) or b) above.
Or	
ASTM D7528, (ROBO Test), aged oil low-temperature viscosity[e]	d) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for original viscosity grade. e) If CCS viscosity measured is higher than maximum viscosity specified for original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade). f) EOT ROBO sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in a) or b) above.

ASTM D7320, (Sequence IIIGB) phosphorus retention, % min	NR	NR	79
Or			
ASTM D8111, (Sequence IIIHB) phosphorus retention, % min	NR	NR	81
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150°C, mPa·s, min	2.3	2.6	2.3
ASTM D6557 (Ball Rust Test), avg. gray value, min[b]	100	100	100
ASTM D5800, evaporation loss, 1 hour at 250°C, % max[f]	15	15	15
ASTM D6417, simulated distillation at 371°C, % max	10	10	10
ASTM D6795, EOFT, % flow reduction, max	50	50	50
ASTM D6794, EOWTT, % flow reduction, max			
with 0.6% H_2O	50	50	50
with 1.0% H_2O	50	50	50
with 2.0% H_2O	50	50	50
with 3.0% H_2O	50	50	50
ASTM D4951 or D5185, phosphorus % mass, max[g]	0.08[g]	NR	0.08[h]
ASTM D4951 or D5185, phosphorus % mass, min[g]	0.06[h]	0.06[h]	0.06[h]
ASTM D4951, D5185, or D2622, sulfur % mass, max[g]			
SAE 0W-16, 5W-16, 0W-20, 0W-30, 5W-20, and 5W-30	0.5[g]	NR	0.5[g]
SAE 10W-30	0.6[g]	NR	0.6[g]
All other viscosity grades	NR	NR	0.6[g]
ASTM D892 (Option A), foaming tendency			
Sequence I, mL, max, tendency/stability	10/0[i]	10/0[j]	10/0[i]
Sequence II, mL, max, tendency/stability	50/0[i]	50/0[j]	50/0[i]
Sequence III, mL, max, tendency/stability	10/0[i]	10/0[j]	10/0[i]
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability[i]	100/0	100/0	100/0
ASTM D6922, homogeneity and miscibility	[k]	[k]	[k]
ASTM D6709, (Sequence VIII) shear stability	[l]	[l]	[l]
ASTM D7097, TEOST MHT, high-temperature deposits, deposit wt, mg, max[g]	35	45	35
ASTM D5133, gelation index, max[b]	12[m]	NR	12[m]
ASTM D6335, TEOST 33C, high-temperature deposits, total deposit weight, mg, max			
SAE XW-16	NR	NR	NR
SAE 0W-20	NR	NR	NR
All other viscosity grades	NR	NR	30

ASTM D7563, emulsion retention	NR	NR	no water separation
ASTM D7216 Annex A2, elastomer compatibility	Table G-5	Table G-5	Table G-5

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.
[a]Tests are per ASTM requirements.
[b]If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the “S” category and there is no API Certification Mark, the Sequence VG (ASTM D6593) or Sequence VH (ASTM DXXXX), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.
[c]Viscosity grades are limited to 0W, 5W and 10W multigrade oils.
[d]Required only for oils claiming to meet API SN with SN PLUS or API SN with SN PLUS and Resource Conserving.
[e]Not required for monograde and 15W, 20W, and 25W multigrade oils.
[f]Calculated conversions specified in ASTM D5800 are allowed.
[g]For all viscosity grades: If CH-4, CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the “S” category limits for phosphorus, sulfur, and the TEOST MHT do not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils. This footnote cannot be applied if CK-4 or FA-4 is also claimed. Note that these “C” category oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.
[h]This is a non-critical specification as described in ASTM D3244.
[i]After 1-minute settling period.
[j]After 10-minute settling period.
[k]Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.
[l]Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade.
[m]To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

Table G-5—Elastomer Compatibility

Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2, The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed herein

Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

Table G-6—Requirements for API Service Category SP and API SP with Resource Conserving

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

Bench Test and Measured Parameter[a]			
Aged oil low-temperature viscosity ASTM D8111, (Sequence IIIHA), aged oil low-temperature viscosity[d] Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either IIIHA or ROBO Measure CCS viscosity of EOT IIIHA or ROBO sample at CCS temperature corresponding to original viscosity grade Or ASTM D7528, (ROBO Test), aged oil low-temperature viscosity[d] Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either IIIHA or ROBO Measure CCS viscosity of EOT IIIHA or ROBO sample at CCS temperature corresponding to original viscosity grade	a) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at MRV temperature specified in SAE J300 for original viscosity grade. b) If CCS viscosity measured is higher than maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade). c) EOT ROBO sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in a) or b) above. d) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at MRV temperature specified in SAE J300 for original viscosity grade. e) If CCS viscosity measured is higher than maximum viscosity specified for original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade). f) EOT ROBO sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in a) or b) above.		
ASTM D8111, (Sequence IIIHB) phosphorus retention, % min	NR	NR	81
ASTM D4683, D4741, or D5481, High Temp./High Shear Viscosity @ 150°C, mPa·s, min	2.3	2.3	2.3
ASTM D6557 (Ball Rust Test), avg. gray value, min[b]	100	100	100
ASTM D5800, evaporation loss, 1 hour at 250°C, % max[e]	15.0	15.0	15.0
ASTM D6795, EOFT, % flow reduction, max	50	50	50
ASTM D6794, EOWTT, % flow reduction, max			
with 0.6% H_2O	50	50	50
with 1.0% H_2O	50	50	50
with 2.0% H_2O	50	50	50
with 3.0% H_2O	50	50	50
ASTM D4951 or D5185, phosphorus % mass, max[f]	0.08[g]	NR	0.08[g]
ASTM D4951 or D5185, phosphorus % mass, min[f]	0.06[g]	0.06[g]	0.06[g]
ASTM D4951, D5185, or D2622, sulfur % mass, max[f]			
SAE 0W-16, 5W-16, 0W-20, 0W-30, 5W-20, and 5W-30	0.5[f]	NR	0.5[f]
SAE 10W-30	0.6[f]	NR	0.6[f]
All other viscosity grades	NR	NR	0.6[f]

ASTM D892 (Option A and excluding paragraph 11), foaming tendency			
Sequence I, mL, max, tendency/stability	10/0[h]	10/0[i]	10/0[h]
Sequence II, mL, max, tendency/stability	50/0[h]	50/0[i]	50/0[h]
Sequence III, mL, max, tendency/stability	10/0[h]	10/0[i]	10/0[h]
ASTM D6082 (Option A), high-temperature foaming mL, max, tendency/stability[h]	100/0	100/0	100/0
ASTM D6922, homogeneity and miscibility	[j]	[j]	[j]
ASTM D6709, (Sequence VIII) shear stability			
SAE XW-16	NR	NR	NR
All other viscosity grades	Stay in grade[k]	Stay in grade[k]	Stay in grade[k]
ASTM D6278, (Diesel Injector) shear stability, KV@100°C after 30 passes, min			
SAE XW-16	5.8	5.8	5.8
All other viscosity grades	NR	NR	NR
ASTM D5133, gelation index, max[b]	12[l]	NR	12[l]
ASTM D6335, TEOST 33C, high-temperature deposits, total deposit weight, mg, max			
SAE XW-16	NR	NR	NR
SAE 0W-20	NR	NR	NR
All other viscosity grades	NR	NR	30
ASTM D7563, emulsion retention	NR	NR	no water separation
ASTM D7216 Annex A2, elastomer compatibility	Table G-7	Table G-7	Table G-7

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.
[a]Tests are per ASTM requirements.
[b]If CI-4, CJ-4, CK-4 and/or FA-4 categories precede the “S” category and there is no API Certification Mark, the Sequence VH (ASTM DXXXX), Ball Rust (ASTM D6557), and Gelation Index (ASTM D5133) tests are not required.
[c]Viscosity grades are limited to 0W, 5W and 10W multigrade oils.
[d]Not required for monograde and 15W, 20W, and 25W multigrade oils.
[e]Calculated conversions specified in ASTM D5800 are allowed.
[f]For all viscosity grades: If CH-4, CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the “S” category limits for phosphorus and sulfur do not apply. However, the CJ-4 limits for phosphorus and sulfur do apply for CJ-4 oils, and the phosphorus limit in the “SP with Resource Conserving” column (0.08% mass maximum) applies when CK-4 with SP or FA-4 with SP is claimed. Note that these “C” category oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.
[g]This is a non-critical specification as described in ASTM D3244.
[h]After 1-minute settling period.
[i]After 10-minute settling period.
[j]Shall remain homogenous and, when mixed with ASTM reference oils, shall remain miscible.
[k]Ten-hour stripped kinematic viscosity must remain in original SAE viscosity grade.
[l]To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

Table G-7—Elastomer Compatibility

Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2, The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed herein

Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

Annex H

Engine Oil Licensing and Certification System (EOLCS) Online Application

The EOLCS Online Application can be found at http://engineoil.api.org. The Online Application asks prospective licensees to provide and current licensees to maintain the following information on licensed oils:

a. Elemental analysis data.
b. Finished oil physical properties.
c. Additive and base oil information.
d. Engine test information (stand code from applicable category engine test, base oil interchange/viscosity grade read across use).
e. Product traceability code information.

Prospective and current licensees are also asked to provide and maintain company and contact information. This includes the following:

a. Company address, phone, fax, and website information.
b. Contact address, phone, fax, and email information.

Additionally, licensed marketers must complete the steps for annual renewal and may periodically be required to respond to audit findings. The audit process is described in Section 8.

Questions on the Online Application should be emailed to the API Helpdesk at teameolcs@api.org. Helpdesk personnel can also be reached at 1-877-562-5187.

Annex I

Glossary

For the purposes of this standard, the following definitions apply:

Administrative Guidance Panel (AGP): A balanced body, consisting of three API and three automotive manufacturer (Ford, General Motors, and DaimlerChrysler) members, that will meet at least annually to evaluate the operation of the EOLCS program.

Aftermarket Audit Program (AMAP): See Section 8 and monitoring, enforcement, and conformance below.

American Automobile Manufacturers Association (AAMA): A trade association that represented car manufacturers headquartered in the United States. AAMA disbanded on May 1, 1999.

Note: On December 16, 1992, the Motor Vehicle Manufacturers Association of the United States (MVMA) changed its name to the American Automobile Manufacturers Association.

American Chemistry Council (ACC): A trade association formerly known as the Chemical Manufacturers Association (CMA) responsible for the development and administration of the Petroleum Additives Panel Product Approval Code of Practice (ACC Code; see Appendix J).

American Petroleum Institute (API): A trade association that promotes U.S. petroleum interests, encourages development of petroleum technology, cooperates with the government in matters of national concern, and provides information on the petroleum industry to the government and the public.

American Society for Testing and Materials (ASTM): A professional society that is responsible for the publication of test methods and the development of test evaluation techniques.

API Base Oil Interchangeability Guidelines: A system that reduces testing costs by permitting the interchangeable use of certain base oils without requiring a full engine and bench test program for each of the base oils. This system is described in detail in Annex E.

API Certification Mark: An API Mark that remains the same for a given application (for example, gasoline, fuel-flexible, light-duty diesel) even if a new minimum engine oil standard or standards are developed.

API Guidelines for SAE Viscosity-Grade Engine Testing: Guidelines established for different oil viscosity grades that allow certain engine and bench test results to be used in lieu of additional testing. These guidelines are described in detail in Annex F.

API Mark: A mark licensed by API and used by oil marketers in connection with engine oil products to certify conformance with quality standards established under the API EOLCS.

API Service Symbol: An API Mark that identifies specific engine oil performance levels by means of alphanumeric Service Categories, SAE viscosity grades, and the Energy Conserving designation as appropriate.

ASTM Test Monitoring Center: An entity within ASTM that monitors the calibration of engine test stands and laboratories (see referenced laboratory).

base oil: A base stock or blend of base stocks used in an API-licensed oil.

Base Oil Interchangeability Guidelines: See API Base Oil Interchangeability Guidelines above.
base stock: A lubricant component that is produced by a single manufacturer (independent of crude source or manufacturing location), that meets the same manufacturer's specification, and that is identified by a unique formula, product identification number, or both.

Base Stock: A lubricant component that is produced by a single manufacturer to the same specifications (independent of feed source or manufacturer's location); that meets the same manufacturer's specification; and that is identified by a unique formula, product identification number, or both. Base stocks may be manufactured using a

variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining. Rerefined stock shall be substantially free from materials introduced through manufacturing, contamination, or previous use

base stock slate: A product line of base stocks that have different viscosities but are in the same base stock grouping and from the same manufacturer.

bench test: A laboratory test that measures various performance parameters of an engine oil.
Chemical Manufacturers Association (CMA): See American Chemistry Council above.

engine oil: A lubricating agent that can be classified according to one or a combination of the viscosity grades identified in Table 1 of the most recent edition of SAE J300. Engine oils are also called motor oils. Engine oils include diesel engine oils and passenger car motor oils (PCMOs).

Engine Oil Licensing and Certification System (EOLCS): An administrative process and legally enforceable system by which API authorizes marketers of engine oil to display an API Mark or Marks on oils that meet specified industry standards, as prescribed in a formal licensing agreement.
engine test: (also called engine sequence test or sequence test) A test of an oil's performance using a full-scale engine operating under laboratory conditions.

formulation identifier: An alphanumeric designation that permits traceability of samples in the marketplace by formulation.

Formulation/stand code: As defined in the ACC Code, a unique identification number that is assigned before engine testing to each candidate oil tested and that identifies the candidate's formulation, sponsor, blend, blend modification, test type, run number, testing laboratory, and test stand.

Guidelines for SAE Viscosity-Grade Engine Testing: See API Guidelines for SAE Viscosity-Grade Engine Testing above.

Independent Lubricant Manufacturers Association (ILMA): A trade association of businesses engaged in compounding, blending, formulating, packaging, marketing, and distributing lubricants.

Interindustry Advisory Group (IAG): Provides advice to the API/Automotive Manufacturers Administrative Guidance Panel regarding the API EOLCS. The Interindustry Advisory Group consists of representatives from organizations such as Ford, General Motors, and Chrysler; ACC; API; ASTM; EMA; ILMA; JAMA; PAJ; SAE; and the U.S. Army.

International Lubricant Specification Advisory Committee (ILSAC): A joint committee of Ford, General Motors, and Chrysler and JAMA members that assists in the development of new minimum oil performance standards.

Japan Automobile Manufacturers Association (JAMA): A trade association that represents automobile manufacturers headquartered in Japan.

license number: An identification number that is issued to a marketer upon successful completion of the licensing process and is used for audit purposes.

licensed fingerprint: The physical and chemical properties of a licensed formulation as defined in the finished oil physical properties and elemental analysis sections of the EOLCS Online Application.

monitoring, enforcement, and conformance: Aftermarket monitoring and enforcement to ensure that representation in the marketplace of API Marks to consumers and compliance with technical specifications are being adhered to, as stated in the API license agreement.

Motor Vehicle Manufacturers Association (MVMA): See American Automobile Manufacturers Association above.

oil marketer: The marketing organization responsible for the integrity of a brand name and the representation of the branded product in the marketplace.

passenger car motor oils (PCMOs): Engine oils for passenger cars, light-duty trucks, and similar vehicles (see also engine oil).

Petroleum Additives Panel Product Approval Code of Practice (ACC Code): A system developed by ACC to register and account for engine tests to help ensure that a lubricant meets a given performance specification. This system is described in detail in Appendix J.

Petroleum Association of Japan (PAJ): A trade association that represents petroleum companies headquartered in Japan and promotes Japanese petroleum interests.

physical and chemical properties: The results from several analytical tests that measure various physical characteristics and ingredients (constituents) of an engine oil.

product traceability code: A code that permits oil samples in the marketplace to be traced by formulation, date of packaging, and source of manufacture.

provisional license: Authority granted by API to a marketer to permit the temporary licensing of a specific engine oil when one of the required engine tests has been declared “out of control” by ASTM. A provisional license may also be granted for an engine oil that is qualified by means of SAE viscosity-grade engine testing “read across” from another provisionally licensed engine oil (see 3.7 for details).

referenced laboratory: An engine testing laboratory that is monitored by the ASTM Test Monitoring Center’s blind reference oil system.

Service Category: An alphanumeric code developed by API to specify a level of performance defined by ASTM D4485 and SAE J183. As new Service Categories are developed, new alphanumeric codes may be assigned.

severity adjustments: Mathematically derived correction factors designed to minimize or eliminate laboratory biases. Severity adjustments are developed by the testing laboratory and confirmed by the ACC Monitoring Agency and the ASTM Test Monitoring Center.

Society of Automotive Engineers (SAE): An engineering society founded to develop, collect, and disseminate knowledge of mobility technology.

Annex J

ACC Petroleum Additives Panel Product Approval Code of Practice

The American Chemistry Council (ACC) Petroleum Additives Panel has developed a Product Approval Code of Practice (the ACC Code) for passenger car motor oils (PCMOs) and diesel engine oils. The ACC Code defines practices to help ensure that a particular engine lubricant meets its performance specifications. This is accomplished through the use of specified engine tests, procedures, and record keeping. The ACC Code went into effect on March 30, 1992. ACC has contracted with the ASTM Test Monitoring Center, Pittsburgh, PA, to serve as the monitoring agency for administration of the ACC Code as related to scheduling and registering engine oil tests.

Compliance with the ACC Code is mandatory to obtain a license to use the API Certification Mark or to use API Service Categories SN, SM, SL, SJ, SH, CH-4, CI-4, CJ-4, CK-4, and FA-4 in the API Service Symbol. Oil marketers licensed against the API SP standard will be permitted to display SP in the API Service Symbol beginning May 1, 2020.

Adherence to the ACC Code as a requirement for the EOLCS will be periodically reviewed for continued suitability and enhancement.

A copy of the ACC Code is not included in this publication. Since ACC has committed to continuous updates, a copy of the most recent edition of the ACC Code may be downloaded from the American Chemistry Council's website at https://www.americanchemistry.com/ProductsTechnology/PAPTG/PAPTG-Code-of-Practice-Resources/Petroleum-Additives-Product-Approval-Code-of-Practice.pdf

The American Chemistry Council is located at 700 Second Street, NE, Washington, DC 20002, USA [telephone (202) 249-6100].

Annex K

Physical and Chemical Ranges for Auditing

Table K-1—API Aftermarket Audit Ranges—Standard Audit

Parameter	Range[a]
Viscosity at 100°C (ASTM D445)	As defined in SAE J300
Cranking viscosity (ASTM D5293)	
All oils	As defined in SAE J300
Energy Conserving oils	+10%[b]
Pumping viscosity (ASTM D4684)	As defined in SAE J300
Pumping yield stress (ASTM D4684)	As defined in SAE J300
HTHS viscosity (ASTM D4683)	
API "S" 1st/ILSAC oils[c]	As defined in SAE J300
Energy Conserving oils	-15%, +10%[d]
API CI-4, CI-4 with CI-4 PLUS, CJ-4, CK-4 and FA-4 oils	As defined in ASTM D4485 or API 1509, as applicable
NOACK volatility (ASTM D5800)	
API "S" 1st/ILSAC oils[c]	As defined in API 1509
Energy Conserving oils	+10%[e]
API CH-4, CI-4, CI-4 with CI-4 PLUS, CJ-4, CK-4 and FA-4 oils	As defined in ASTM D4485 or API 1509, as applicable
Elements with published specification [ICP-(ASTM D4951 or D5185)]	
Phosphorus	As defined in ASTM D4485 or API 1509, as applicable
Sulfur	As defined in ASTM D4485 or API 1509, as applicable
Elements with no published specification [ICP (ASTM D4951 or D5185 + D5762)][f]	
Values ≥100 parts per million	–10%, +15%
Values <100 parts per million	–15%, +20%
Total Base Number (ASTM D2896)	–10%, +15%

Note: HTHS = high temperature/high shear; ICP = inductively coupled plasma; ASTM D5762 measures Nitrogen.

[a] ASTM analytical test method precision will be accounted for when applying the acceptance range.

[b] Maximum = Online Application reported value x 1.10 (+10% tolerance) x 1.073 (7.3% Reproducibility) or J300 adjusted for Reproducibility, if lower.

[c] Applies to specifications for API SJ, API SL, API SM, API SN, ILSAC GF-4, or ILSAC GF-5, as applicable.

[d] Maximum = Online Application reported value x 1.10 (+10% tolerance) x 1.036 (3.6% Reproducibility)/Minimum = Online Application reported value x 0.85 (-15% tolerance) x 0.964 (-3.6% Reproducibility) or J300 minimum adjusted for reproducibility, if higher.

[e] Maximum = Online Application reported value x 1.10 (+10% tolerance) + 1.0 (Reproducibility) or API 1509 Max + 1.0 Reproducibility, if lower.

[f] The elements to be reported and audited are those included in the EOLCS Online Application.

Table K-2—API Aftermarket Audit Ranges—Expanded Audit

Parameter	Range[a]
Foaming (ASTM D892, all sequences)[b]	Max +10 ml[c]
High temperature foaming (ASTM D6082)	Max +10 ml[c]
Shear stability (ASTM D6278)	
SL, SM & SN oils	d, e
CH-4 & CI-4 oils	f
Shear stability (ASTM D7109)	
CI-4 with CI-4 PLUS, CJ-4, CK-4, and FA-4 Oils	g
Ball rust test (D6557)	h
HTCBT (ASTM D6594)	i
ROBO (ASTM D7528)—MRV Only	j

Note: HTCBT = High Temperature Corrosion Bench Test; ROBO—MRV Only = ROBO Bench Oxidation Test measuring used oil MRV per ASTM D7528

[a]ASTM analytical test method precision will be accounted for when applying the tolerance limits.

[b]Use Option A for API SJ, API SL, API SM, API SN, ILSAC GF-4, and ILSAC GF-5. Settling time = 1 minute for API SN/ILSAC GF-5 oils and 10 minutes for all other oils. No Option A for API CH-4, CI-4, CI-4 with CI-4 PLUS, CK-4, or FA-4. Option A may be used for API CJ-4.

[c]Added to API SJ, API SL, API SM, API SN, ILSAC GF-4, or ILSAC GF-5 specification limits, as applicable

[d]Apply limits outlined in API 1509, Appendix F, Table F-2, Footnote 6.

[e]Non-conformance to limits outlined in API 1509, Appendix F, Table F-2 Footnote 6 leads to a request for licensee to confirm Sequence VIII Stay-in-Grade support.

[f]Refer to API CH-4 or CI-4, as applicable.

[g]Refer to API CI-4 with CI-4 PLUS, CJ-4, CK-4, or FA-4, as applicable.

[h]Refer to API SJ, API SL, API SM, API SN, ILSAC GF-4 or ILSAC GF-5 specifications, as applicable.

[i]Refer to API CH-4, CI-4, CI-4 with CI-4 PLUS, CJ-4, CK-4 or FA-4 as applicable.

[j]Refer to API SM, API SN, ILSAC GF-4 or ILSAC GF-5 specifications, as applicable.

Annex L

Guidelines for Selection of Product and Engine Test Audits

L.1 General

As part of API's Aftermarket Audit Program, engine tests will be conducted on randomly selected licensed engine oils purchased from the aftermarket. The selection of products to be engine tested will be based on the total volume of engine oil licensed by each marketing company. Although the examples of random selection use "balls from a pot," the actual random selections will be computer-assisted.

L.2 Selection of Marketing Company

A pot will contain one ball for each marketing company that holds an API license. This same pot will contain an additional ball for each 1 million gallons (or portion thereof) over 1 million gallons of API-licensed engine oils (see Table L-1).

L.3 Selection of Engine Test

A separate pot will contain one ball for each engine test to be conducted in a calendar year. The total number of engine tests for each particular engine test type will be determined before any engine testing is conducted (see Table L-2).

L.4 Selection of Viscosity Grade

A predetermined number of engine tests will be conducted on each viscosity grade of licensed oil each year. A pot will contain one ball for each viscosity grade to be tested each year (see Table L-3).

L.5 Selection Process

L.5.1 A ball will be selected from the pot containing the names of the engine tests.

L.5.2 A ball will be selected from the pot containing the names of the marketing companies.

L.5.3 A ball will be selected from the pot containing the viscosity grades to be tested. In the event that the marketing company does not have an API license for the viscosity grade selected, the ball will be returned to the pot, and another will be selected. This process will continue until a ball is selected that matches a viscosity grade marketed by the licensed company.

L.6 Other Selection Criteria

L.6.1 In the event that a selected marketing company markets two or more brand names of the selected viscosity grade, a ball for each brand name will be placed in a pot, and a brand name will be selected.

L.6.2 In the event that a selected marketing company does not market a viscosity grade remaining in the pot, a ball for each viscosity grade marketed by the selected marketing company will be placed in a pot, and a viscosity grade will be selected.

Table L-1—Marketing-Company Pot: Example

Company	Volume (millions of gallons)	Number of Balls	Chance of Selection (%)
A	0.9	1	0.11
B	1.5	2	0.22
.	.	.	.
.	.	.	.
.	.	.	.
M	4.4	5	0.55
N	9.2	10	1.09
.	.	.	.
.	.	.	.
X	50.2	51	5.59
Y	100.5	101	11.06
Z	200.0	200	21.9
Total	900.0	913	100

Table L-2—Sequence-Test Pot: Example

Sequence Test	Number of Balls	Percentage
IIIF	6	30
IVA	3	15
VG	6	30
VIII	5	25
Total	20	100

Table L-3—Viscosity-Grade Pot: Example

Viscosity Grade	Number of Balls	Percentage
SAE 5W-30	8	40
SAE 10W-30	9	45
SAE 10W-40	2	10
SAE 20W-50	1	5
Total	20	100

Annex M

API Mark Conformance Audit: Engine Tests

M.1 General

The oil licensee does not need to prove that the oil meets or exceeds the required performance standards, only that the engine oil performance, as measured by an engine test conducted in accordance with the ACC Code, is not below the allowed performance band set at a 95-percent confidence level (one-tailed test). In other words, an oil is assumed to meet or exceed the required performance standard unless proved otherwise. If an aftermarket engine oil yields a test result that does not meet the testing criteria described in M.2, the licensee will be notified that the oil has been found to be out of conformance. The licensee must respond to API on the nonconformity within 30 days of notification. The licensee may elect to pay for additional engine testing, in which case the oil's conformance to the performance standards will be evaluated using the Multiple Test Evaluation Procedure (see Annex N). Additional engine testing related to this conformance evaluation shall be scheduled within 60 days of the original notification and conducted in accordance with the ACC Code. If the additional results are to be included in the conformance evaluation, the specific product to be tested shall be approved by the API EOLCS Manager before the start of engine testing.

M.2 Confidence Level

When engine sequence tests are conducted as part of the Aftermarket Audit Program, conformance will be determined at the 95-percent confidence level using industry published standard deviation data. Non-conformance will be subject to enforcement action as described in paragraph M.1 and Section 8—System Monitoring, Enforcement, and Conformance.

M.3 Statistical Testing Criteria

The statistical testing criteria are as follows:

H_0: True oil performance meets or exceeds the performance limit,

H_1: True oil performance does not meet the performance limit.

The decision rules are as follows:
The oil fails the test (that is, H_0 is rejected) if the following is true:

$$\overline{X} < PL - Z_{0.05}\frac{s}{\sqrt{n}}$$

Equivalently, the oil passes the test (that is, H_0 is not rejected) if the following is true:

$$\overline{X} \geq PL - Z_{0.05}\frac{s}{\sqrt{n}}$$

where:

$\overline{X}$	=	average performance of the oil,
s	=	industry published standard deviation based on reference oil testing conducted on ACC-participating test stands,
n	=	number of tests,
$Z_{0.05}$	=	95-percent (one-tailed) confidence coefficient from a standard normal table,
	=	1.645,
PL	=	performance limit, as defined by the applicable performance standard.

M.4 Example

The performance limit for a test is defined as 6.5 on a 0–10 merit scale. The industry published standard deviation is 0.221. If a random aftermarket engine oil test yields a result of 6.0, the oil would be found to be out of conformance.

If additional testing is conducted, this parameter's performance must exceed the values listed in Table M-1.

Table M-1—Example

Number of Tests (n)	Minimum Average Needed to Pass Audit (X)[a]
1	6.14
2	6.24
3	6.29
5	6.34

[a]Confidence level at 95 percent.

Annex N

Multiple Test Evaluation Procedure

N.1 General

The Multiple Test Evaluation Procedure (MTEP) is any databased approach for evaluation of the quality and performance of a formulation where more than one test has been run. The applicable tests and parameter values to be averaged are specified in Table N-1 for PCMOs and N-2 for diesel engine oils and listed in ASTM D4485.

N.2 Passenger Car Motor Oils

For the API Certification Mark or for Service Category SN and/or SM and/or SL and/or SJ and/or SH where specifications do not include a defined MTEP for those tests listed in Table N-1, the criteria expressed in the ACC Code, Appendix F, must be followed.

N.3 Diesel Engine Oils

For API Service Categories CH-4, CI-4, CJ-4, CK-4 and FA-4, the limits of a specification have been expressed in terms of a defined MTEP technique. To determine the acceptability of a candidate oil formulation, the value of the parameters in each of the tests (appropriate to the respective specification) listed in Table N-2 must be treated in accordance with ASTM D4485.

Table N-1—Parameter Values to Be Averaged for PCMO

Test Method	Type of MTEP	Rated Parameter (Units)[a]
Sequence IIIF	MTAC	*Kinematic viscosity (% increase at 40°C)*
	MTAC	Average piston skirt varnish (merits)
	MTAC	Weighted piston deposit (merits)
	MTAC	Screened avg. cam plus lifter wear (μm)
	[b]	Hot stuck rings
Sequence IIIG	MTAC	*Kinematic viscosity (% increase at 40°C)*
	MTAC	Weighted piston deposit
	MTAC	*Avg. cam plus lifter wear (μm)*
	[b]	Hot stuck rings
Sequence IIIGA	None	No MTEP, No MTAC
Sequence IIIGB	MTAC	Phosphorus retention (%)
Sequence IIIH	MTAC	*Kinematic viscosity (% increase at 40°C)*
	MTAC	Weighted piston deposit
Sequence IIIHA	MTAC	*MRV Viscosity (%)*
Sequence IIIHB	MTAC	Phosphorus retention (%)
Sequence IVA	MTAC	Avg. cam wear (μm)
Sequence VG	MTAC	Average engine sludge (merits)
	MTAC	Rocker arm cover sludge (merits)
	MTAC	Average piston skirt varnish (merits)
	MTAC	Average engine varnish (merits)
	MTAC	*Oil screen clogging (%)*
	[c]	Hot stuck compression rings[c]
Sequence VH	MTAC	Average engine sludge (merits)
	MTAC	*Rocker arm cover sludge (merits)*
	MTAC	Average piston skirt varnish (merits)
	MTAC	Average engine varnish (merits)
	[c]	Hot stuck compression rings[c]
Sequence VIB	MTAC	Fuel economy improvement (FEI 1, FEI 2, FEI 1+FEI 2) (%)
Sequence VID	MTAC	Fuel economy improvement (FEI 2, FEI SUM, FEI 1+FEI 2) (%)
Sequence VIE	MTAC	Fuel economy improvement (FEI 2, FEI SUM, FEI 1+FEI 2) (%)
Sequence VIF	MTAC	Fuel economy improvement (FEI 2, FEI SUM, FEI 1+FEI 2) (%)
Sequence VIII	MTAC	Bearing weight loss (mg)
Sequence IX	MTAC	*Average number of preignitions*

[a]Units for parameters in italics are transformed. See ACC Code of Practice for specific transformations
[b]The majority of retained tests must not have ring sticking (hot stuck).
[c]The majority of retained tests must not have compression ring sticking (hot stuck).

Table N-2—Parameter Values to be Averaged for Diesel Engine Oils

Engine Test	Type of MTEP	Rated Parameter (Units)[a]
Sequence VIII	MTAC	Bearing weight loss
Sequence IIIFHD	MTAC	*Kinematic viscosity at 60 hours (% increase)*
Sequence IIIG	MTAC	Kinematic viscosity (% increase at 40°C)
	MTAC	Weighted piston deposit (merits)
	MTAC	Average cam plus lifter wear (µm)
	[b]	Hot stuck rings
1K	TLM	WDK (demerits)
	TLM	Top groove fill (%)
	TLM	*Top land heavy carbon (%)*
	TLM	Average oil consumption (g/kW h)
	[c]	Piston ring sticking (yes or no)
	[d]	Piston, ring, and liner scuffing (yes or no)
1N	TLM	WDN (demerits)
	TLM	Top groove fill (%)
	TLM	*Top land heavy carbon (%)*
	TLM	Oil consumption (g/kWh)
	[c]	Piston ring sticking (yes or no)
	[d]	Piston, ring and liner scuffing (yes or no)
1P	TLM	WDP (demerits)
	TLM	Top groove carbon (demerits)
	TLM	Top land carbon (demerits)
	TLM	*Average oil consumption (0 to 360 hours) (g/h)*
	TLM	*Final oil consumption (312 to 360 hours (g/h)*
	[d]	Piston, ring, and liner scuffing (yes or no)
1R	TLM	WDR (demerits)
	TLM	Top groove carbon (demerits)
	TLM	Top land carbon (demerits)
	TLM	Average initial (0 to 252 hours) oil consumption (g/h)
	TLM	Average final (432 to 504 hours) oil consumption (g/h)
	[d]	Piston, ring, and liner scuffing (yes or no)
C13	MRS	*Caterpillar C13 merits*
	[c]	Delta oil consumption (g/h)
	[e]	Average top land carbon (demerits)
		Second ring top carbon (demerits)
		Second ring top carbon (demerits)
ISM	MRS	Cummins ISM merits
	[e]	Crosshead weight loss (mg)
		Injector screw wear (mg)
		Oil filter pressure delta (kPa)
		Sludge (merits)
	TLM	Top ring weight loss
ISB	TLM	Average camshaft wear (µm)
	TLM	Average tappet weight loss (mg)
T-8	TLM	Viscosity increase at 3.8% soot (cSt)
	TLM	Filter plugging, differential pressure (kPa)
	TLM	Oil consumption (g/kWh)
T-8E	TLM	Relative viscosity at 4.8% soot (unitless number)
	TLM	Viscosity increase at 3.8% soot (cSt)
T-11	TLM	TGA % soot at 4, 12, and 15 cSt increase at 100°C
T-12	TLM	Liner wear (µm)
[f]		Top ring mass loss (mg)
		Lead content at EOT (mg/kg)
T-12	MRS	Cylinder liner wear (µm)
[g]		Top ring mass loss (mg)
		Delta Pb@EOT (mg/kg)

		Delta Pb 250 to 300 hours (mg/kh)
		Oil consumption (g/hr)
T-12	MTAC	Top ring mass loss (mg)
h	i	Cylinder liner wear (µm)
T-13	TLM	IR peak at EOT (Abs, cm^{-1})
		Kinematic viscosity increase at 40°C
COAT	MTAC	Average aeration, 40h to 50h (%)
	i	

[a]Units for parameters in italics are transformed. See ACC Code of Practice for specific transformations
[b]The majority of retained tests must not have ring sticking (hot stuck).
[c]None of the retained tests may have piston ring sticking.
[d]If three or more operationally valid tests have been run, the majority of these tests must not have scuffing. Any scuffed tests are considered non-interpretable, and no data from these tests are to be used in MTEP calculations.
[e]The parameters used in calculating the Merit Rating value are shown.
[f]This TLM applies to Mack T-12 used in API CH-4.
[g]This MRS applies to Mack T-12 used in API CI-4 and CJ-4.
[h]This MTAC applies to Mack T-12 used in API CK-4 and FA-4
[i]The MTAC provision to discard any valid test result is not applicable (see ACC Code of Practice Appendix F, three or more tests, number 2).

Annex O

Technical Interpretations of API 1509

API 1509 is an API Standard. API Policy and Procedure Number 104, Subject: Standardization, provides general guidance for API Standards activities. Policy Number 104 allows API to provide written "interpretations . . . on the meaning of a standard."

Note that the EOLCS License Agreement (Part C), Section 3, states in part "Licensee agrees to comply with . . . any interpretations of API 1509."

No. 1

Question: What is a definition of "complete engine testing" as found on the EOLCS application form?

Answer: "Complete engine testing" means that the oil has passed each engine test required for licensing of that oil (see Annex G). Where applicable, (for all "S" Category oils) the oil must have been registered with the American Chemistry Council (ACC) monitoring agency (Registration Systems, Inc.) and have passed each test in full compliance with the ACC Product Approval Code of Practice. When a complete engine test program has been successfully completed on an oil, API Guidelines for SAE Viscosity-Grade Engine Testing, Annex F, can be applied for licensing. The intent of "complete engine testing" is to distinguish between oils which have been fully tested and those that are licensed by reference to "read across."

No. 2

Question: On the EOLCS application Product Traceability Code, is the day and time of manufacture actually required to be submitted as part of the EOLCS application for licensure?

Answer: The Introduction to Part D—Product Traceability Code states in part " . . . API is mandating, as a requirement of licensing, that each container of licensed oil marketed be legibly date stamped (bolding added) and that sufficient information be provided in licensing documents to allow API to interpret the date stamp and match the audited oil with the licensing data for that oil."

No. 3

Question: Is the API ILSAC mark design in Figure O-1 acceptable for display on containers?

Figure O-1—Incorrect API ILSAC Mark Design

Figure O-2—Correct API Mark Design

Answer: No. Figure 1 (reprinted in Figure O-2) of API 1509 shows how the mark must appear on labels; Section 7.2 specifies design requirements for the mark. Paragraph 7.2.2 states in part, "The background of the outer band (bold added) . . . shall be a color that contrasts with the label background." The specific error in Figure O-1 is that the outer band has been separated into two bands of different colors.

No. 4

Question: A marketer of motor oil, for example a car manufacturer, sells oil under its own name. The marketer purchases its branded oil from several different oil companies, each of which use a completely different format for its product traceability code. How should this be handled under EOLCS?

Answer: Each separate formulation supplied to the marketer must be filed with and accepted by API on a Part B form Product Data Sheet. Each Part B has space for four (4) separate formulations. If a marketer has more than 5 formulations an additional Part B form must be submitted in the licensing document.

API must be able to compare data obtained from oils analyzed under the aftermarket audit program with the data for that oil submitted to API as part of the licensing program. Therefore, an interpretation of the Formulation Code identifier required on Part B for each oil must be available to API. The marketer should submit a separate Part D form, Product Traceability Code, for each formulation and link the information in Part D with Part B.

Please refer to the Introduction to Part D—Product Traceability Code which states in part " . . . API is mandating, as a requirement of licensing, that each container of licensed oil marketed be **legibly date stamped** (bolding added) and that sufficient information be provided in the licensing documents to allow API to interpret the date stamp and match the audited oil with the licensing data for that oil."

No. 5

Question: With regard to the administration fee, does one fee cover the various oils listed on the Application Form? With regard to the volume fee, is this based on the total sales of the various oils on the Application Form? (It is assumed that the volume of each grade is not separately assessed.)

Answer: There are two fees as described in 3.2 of API 1509. The Administration fee is a flat fee payable by all licensees. It covers all licensed oils. The volume of sales fee covers the total sales of licensed oils, that is, the "oils listed on the Application Form." The volume of sales fee is not separately assessed.

No. 6

Question: On the EOLCS application Part D—Product Traceability Code, does the "date stamp" requirement refer to (a) the date of manufacture or packaging, and (b) is the actual day (italics added) of either manufacture or packaging required?

Answer: (a) You must use date of packaging for the date stamp and (b) the day of packaging is required.

No. 7, amended

Question: Assume there are two Group I base oils from different manufacturers, both of which have passed engine and bench tests with given (bolding added) additive and VI packages and both individual base oil/additive blends are licensed "SH."

Could a packager purchase these two different sourced base oils, mix them together (bolding added) with the given additive/VI package and have an API licensed motor oil? This assumes 1) the SAE viscosity grade of the theoretical blend was one licensed for each base oil, and 2) the additive/VI packages and treat levels of the two licensed formulations were consistent.

Answer: Refer to Section E.2.1.5: "Base stocks approved under the provisions of these guidelines may be commingled without further testing."

No. 8

Question: Annex E, Section 2.2.2 is as follows:

Complete performance documentation is required for the original PCMOs. The detergent inhibitor (DI) and/or viscosity modifier (VM) remain unchanged when interchange base oils are tested, except as provided by **the ACC Code** (bolding added). A base oil interchange obtained under these guidelines applies to a single PCMO formulation. In the event of a change in the DI and/or VM outside of the ACC Code, these guidelines shall be **reapplied** (bolding added).

What part of **the ACC Code** is referred to?
How should the guidelines (BOIG) be **reapplied**?

Answer: In the ACC Code, proposed changes in the "core data set" are accomplished by applying Annex H, Guidelines for Minor Formulation Modifications. Proposed changes in a "program" are accomplished by applying Annex I, Program Guidelines.

The BOIG should be reapplied as follows. If the VM/DI concentration in the interchange base oil differs from the original PCMO oil by more than the variation authorized under the ACC Code (Annex H or I), then complete performance documentation is required for the new PCMO with the interchange basestock.

No. 9

Question: On the EOLCS application Part D—*Product Traceability Code*, is it adequate to indicate only the month and year of manufacture?

Answer: No. The day of manufacture is also required. This response assumes that the date of "manufacture" and "packaging" is the same day.

The Introduction to Part D—Product Traceability Code states in part ". . . API is mandating, as a requirement of licensing, that each container of licensed oil marketed be **legibly date stamped** (bolding added) and that sufficient information be provided in the licensing documents to allow API to interpret the date stamp and match the audited oil with the licensing data for that oil."
The date that appears on the container that is selected for aftermarket auditing must be the date of packaging.

No. 10

Question: Part B of the EOLCS Application for Licensure specifies a test method for measuring sulfur and nitrogen which is not addressed in the text of API 1509. Are licensees bound by requirements specified in the Application for Licensure?

Answer: Yes, the API License Agreement requires licensees to comply with all requirements specified in API 1509 and the Application for Licensure.

Question: If test methods for measuring Physical and Chemical Properties are specified in API 1509, may marketers utilize alternate (but equivalent) test methods to measure these properties?

Answer: No. The properties must be measured by the methods specified in API 1509.

No. 11

Question: In Annex G—Requirements for API Service Categories SH, SJ and SL by Viscosity Grade, the last column in Table G-1 titled "All Other Grades" has an NR for all Bench Tests and the L-38 shear stability test. NR means No Requirement. Following is a review of NR.

Answer: The technical language which describes API Service Category SH specifically mandates the application of specified parts of ILSAC GF-1 or DOD CID A-A-52039 specifications for all viscosity grades covered by these specifications. This includes the three oils specifically noted in Annex G (SAE 5W-30, 10W-30 and 15W-40) and any other oils which are requested to be licensed under ILSAC GF-1. Also, the most recent edition of SAE J300 contains high temperature/high shear requirements for SH.

Annex G, Table G-1, as it appears in API 1509, is correct with the addition of the SAE J300 requirements as noted above. If ASTM subsequently adopts requirements for SH, these requirements will be presented to the appropriate committees for consideration as an amendment to API 1509.

No. 12

Question: If an oil company sells its oil to another company and that company resells the oil under its own brand name does the reseller have to be licensed?

Answer: Yes. Section 4.1 of API 1509 includes the following statements. EOLCS is "…a licensing system that includes a formal license agreement executed by the marketer with API." An oil marketer " is defined as the marketing organization responsible for the integrity of the brand name and the representation of the branded product in the marketplace."

Section 9 of the EOLCS License Agreement is as follows:

> 9. Licensee agrees that it is the marketing organization responsible for the integrity of the brand name and the product's representation in the marketplace **and agrees to use the marks only on products bearing the Licensee's name** (bolding added).

The Licensee's name on the product is the key element. If the owner company's name appears on the container it may license the oil. If the subsidiary's name appears on the container, the subsidiary must be separately licensed.

No. 13

Question: Can a result of 2.69 on a Sequence VI candidate oil test be rounded to 2.70 so as to claim an EFEI of ECII on an EOLCS Application for Licensure?

Answer: Yes. Rounding of Sequence VI candidate test values is done in accord with ASTM E 29–89, Section 2.3 and 4. *Rounding-Off Method*.

References:

ASTM E 29–89 *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*.

> 2.3 Rounding Off Method—In other fields, specification limits of (for example), 2.5 inches max, 2.50 inches max, 2.500 inches max are taken to imply that, for purposes of determining conformance with specifications, an observed value or a calculated value should be rounded off to the nearest 0.1 inch, 0.01 inch, 0.001 inch, respectively, and then compared with the specification limit.

API 1509, *API Engine Oil Licensing and Certification System*, 12th Edition, January 1993. Table D-1, page 19.

Fuel Efficiency ASTM RR-D:2-1204 Sequence VI Test improvement (EFEI) 2.7% (min).

No. 14

Question: What is the difference between Table K-1 “Tolerance Limits for Standard Audit” and Table K-2 “Limits for Expanded Audit” in Annex K? Are Tables K-1 and K-2 applied to API SH oils throughout the world? Is there any difference in their frequency?

Answer: Each oil selected for testing under the provisions of the Aftermarket Audit Program (AMAP) will be audited using the tests in Table K-1, as appropriate for the viscosity grade. Table G-1 should be consulted for guidance on tests that apply to different viscosity grades for SH oils. Oils for testing and the frequency of testing under Table K-2 will be selected by reference to an API protocol. Audit samples are selected worldwide.

No. 15

Question: A marketer has successfully completed an ACC-registered DDC 6V92TA test on an SAE 15W-40 engine oil. This engine oil has also been qualified against API CH-4 through the application of Base Oil Interchange (BOI) according to Table E-9 of API 1509. Because it is API CH-4 qualified, it also meets the requirements for API CF (i.e., Caterpillar 1M-PC testing is waived according to Table E-6 of API 1509).

Does the SAE 15W-40 described above qualify for licensing as API CF-2?

Answer: The SAE 15W-40 oil qualifies for API CF-2 because it passed the 6V92TA test, as required by API 1509. The question correctly notes that CAT 1M-PC testing is waived because the product meets CH-4 interchange requirements as noted in footnote c of Table E-6.

No. 16

Question: A company uses the solvent refining process to produce 150N Group I base stocks at separate refineries. Refined from different crude oil sources, the base stocks display unique properties when tested according to ASTM D445, D 2270, D 4052, and D 2622.

Are these base stocks considered the same base stock slate per E.1.2.2 of API 1509, 14th Edition?

Answer: The two stocks as described above would not be considered as coming from the same base stock slate as defined in E.1.2.2 of API 1509. That definition refers to base stocks in the same grouping and from the same manufacturer but having different viscosities. The two stocks described above have the same viscosity. It would be more likely that they could be called the same base stock if they were produced to the same specifications, used the same formulation, and had the same product identifier (see API 1509, E.1.2.1).

If the company chooses to consider both 150N base stocks the same, there are some issues that need to be taken into account. Since the base stocks display some unique properties, the company needs to select the more severe of the two stocks to conduct performance testing or commit to proving equivalent performance by testing both. That responsibility is not removed by producing them under the same specification.

If the company chooses to identify the Group I base stocks separately, they would be subject to the applicable base oil interchange guidelines in Annex E of API 1509.

No. 17

Question: A single base stock manufacturer makes Group I, Group II, and/or Group III base stocks by a variety of different processes. This includes manufacturing base stocks by mixing a Group I with a Group II (or Group III) or mixing a Group II with a Group III. This mixed base stock is associated with a manufacturer's specification and product identification number. According to API 1509, this mixed Group base stock should be marketed as a Group I, or Group II, or Group III base stock based on the saturates, sulfur and VI analysis of the product as sold. For example:

- If the saturates are < 90%, and sulfur is > 0.03%, and VI is > 80 and < 120, the base stock is a Group I.
- If the saturates are > 90%, and sulfur is < 0.03%, and VI is > 80 and < 120, the base stock is a Group II.
- If the saturates are > 90%, and sulfur is > 0.03%, and VI is > 80 and < 120, the base stock is a Group I.
- If the saturates are > 90%, and sulfur is < 0.03%, and VI is > 120, the base stock is a Group III.

There has been some debate on this issue, especially on the correct labeling of the third example listed above. Do the examples above correctly interpret the guidelines set forth in API 1509?

It is understood that the base stock manufacturer retains responsibility for supplying commercial product with performance capability at least equivalent to that tested in formulations. It is also understood that API 1509 does not limit base stocks by manufacturing process. According to E.1.2.1 of API 1509, "Base stocks may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining."

Answer: The four examples above do correctly interpret the base stock category guidelines set forth in E.1.3 of API 1509. In the third example, the high sulfur content makes the base stock a Group I. According to API 1509, "Group I base stocks contain less than 90 percent saturates and/or greater than 0.03 percent sulfur and have a viscosity index greater than or equal to 80 and less than 120 using the test methods specified in Table E-1."

No. 18

Question: A marketer of a fully qualified SAE 10W-40 API CH-4/SJ product wishes to substitute Group III/IV base oils for the Group I base oils used in the original formulation. The marketer believes this substitution is permitted based on a clause in Annex I Section 5 of the ACC Code of Practice: "Following completion of a program according to the ACC Code of Practice, substitution of Group III or Group IV base stock for Group I and/or Group II base stock is allowed with Level 2 support." The marketer's Level 2 support is full engine test data on an SAE 0W-30 API CH-4/SJ oil using a mixture of Group III and Group IV base oils.

Can a marketer use Annex I, Section 5 of the ACC Code of Practice to justify the substitution of Group III and Group IV base oils for Group I oils in a fully qualified SAE 10W-40 API CH-4/SJ product without further testing?

Answer: API 1509 contains the only authorized base oil interchange (BOI) and viscosity grade read across (VGRA) guidelines for API-licensed products. The ACC Code of Practice is not applicable in this situation.

Taking into account the base oil information provided above, a marketer could qualify the 10W-40 API CH-4/SJ formulation in at least two ways:

- Run complete engine testing for both the CH-4 and SJ categories as recommended in Annex E of API 1509.
- Use the VGRA guidelines in Annex F of API 1509. These recommend complete engine testing for CH-4 proof of performance but could offer some relief for SJ proof of performance.

The marketer of the formulations has the final responsibility for assuring that the products meet API requirements.

No. 19

Question: A marketer wants to qualify a new SJ engine oil formulation using SL/Energy Conserving tests and results from a double-length Sequence IIIE engine test in lieu of a Sequence IIIE test. The API Lubricants Standards Group approved the use of SL/Energy Conserving tests to qualify SJ oils as of May 1, 2000. The committee also instituted Provisional Licensing on that date to address a shortage of parts limiting the availability of Sequence IIIE tests.

Can a double-length Sequence IIIE be used to qualify a formulation for full SJ licensing?

Answer: No, the formulation cannot qualify for full licensing using the double-length Sequence IIIE results. To qualify for SJ, an oil must meet the most recent technical criteria set forth in ASTM D4485 (see 3.4.2 of API 1509). Currently, D 4485 does not include performance criteria for double-length IIIE's.

Assuming the marketer cannot run a standard IIIE, his only recourse for licensing the SJ formulation at this time is to apply for Provisional Licensing. The procedures for Provisional Licensing require the marketer to submit Level 2

support data as described in the ACC Code of Practice. Although the double-length IIIE could not be used to qualify the formulation for full licensing, its results can be used as Level 2 support for Provisional Licensing.

No. 20

Question: On Page 3 of 3 of Part B of the API Application for Licensure, a note states the following: "Additionally, I attest that all engine and bench test data submitted or referred to on this form has been generated using ASTM/ACC calibrated instruments when applicable."

In the statement above, what does the phrase "when applicable" mean. The hypothetical question below should help to illustrate the question:

At the start of GF-2, if a marketer ran a D 5133 Gelation Index test one day prior to the start of TMC surveillance, would this data have been acceptable? One argument would state that since TMC calibration did not apply at the time of the test, the data should be acceptable. Another argument would state that since ASTM intended to calibrate the test—and was in the process of doing so—the data are not valid because it did not come from calibrated equipment.

Answer: Part B of the API Application for Licensure includes the phrase "when applicable" to cover those situations where a calibration requirement does not exist for a test at the time an application for licensure is filed with API. If ASTM has a calibration requirement in place for a test at the time an application is filed, then a calibrated result is required.

If, as noted in the hypothetical question above, a marketer runs a Gelation Index test one day prior to the start of TMC surveillance, the test result would be acceptable only if the marketer files the application for licensure the same day. The result would not be acceptable on an application filed the day after TMC surveillance has begun. This interpretation also applies in a situation where one marketer submits an application for a license before a calibration requirement is in place, and another marketer submits one after the requirement has been implemented. The second marketer must provide a result from a calibrated test.

Please note that the marketer of the formulations has the final responsibility for assuring its products meet API requirements.

No. 21

Question: A marketer of a fully qualified SAE 10W-40 API SJ/CF product wishes to replace 30 percent of the original formulation's Group I base oil with a Group IV and market the product as an SAE 5W-40 API SJ/CF engine oil without further engine testing. The marketer believes this change is possible according to Table E-2 of API 1509. The DI package and VI remain the same, and the base oil viscosities at 100°C are nearly identical. The 5W-40 viscosity grade is a result of the introduction of PAO.

Can a marketer replace 30 percent of a fully qualified 10W-40 SJ/CF's Group I base oil with a Group IV and market the product as a 5W-40 SJ/CF without further testing?

Answer: The answer to the question is no. The marketer must perform additional CF testing to qualify the 5W-40 oil.

To understand why further testing is required, a review of the guidelines for base oil interchange (BOI) and viscosity grade read across (VGRA) found in Annexes E and F of API 1509 is necessary. Under the guidelines spelled out in Annex E, the BOI described in the question above is possible. Tables E-2 (for SJ) and E-6 (for CF) permit the replacement of up to 30 percent of Group I base oil with a Group IV.

With the question of BOI settled, the marketer must then turn to the VGRA rules in Annex F. Again, the SJ and CF guidelines must be addressed separately. For SJ oils, read across from a viscosity grade is permitted as long as three criteria are met:

- The detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the maximum allowed by the ACC Code of Practice.

- Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method.
- The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade.

If all these criteria are met, the marketer does not have to run additional SJ tests. However, no such criteria exist for CF. There are currently no read across rules for CF oils that would allow a marketer to read across from a 10W-40 oil to a 5W-40. Further testing on the 5W-40 oil is required to qualify it as CF.

No. 22

Question: Does the blending of base stocks alone constitute manufacturing?

Answer: Base stock blending may be part of the manufacturing process but does not alone constitute manufacturing of a base stock. All base stock components used to blend a base stock must be produced by a single manufacturer; blended to meet the same manufacturer's specification for that base stock; and identified by a unique formula, product identification number, or both.

No. 23

Question: Are there any geographical restrictions on the manufacturer?

Answer: The base stock definition in API 1509, Annex E.1.2.1, states that a base stock is independent of manufacturing location as long as the base stock is produced by a single manufacturer to the same specification, the base stock meets the manufacturer's specification, and the base stock is identified by a unique formula.

No. 24

Question: Does the API definition of a base stock conflict with the ATIEL letter of conformance for base stock manufacturers which requires conformance with an ISO 9001 or equivalent quality system?

Answer: API 1509 does not explicitly require that a base stock manufacturer adhere to a quality system such as ISO 9001, but such a system would help ensure a base stock meets the definition of base stock in E.1.2.1 of Annex E.

Annex P

EOLCS Licensing Clarifications

Licensing Clarifications are provided to assist Licensees in meeting licensing requirements.

Licensing Clarification: February 5, 1993

Question: A foreign oil company (API licensed) wishes to keep confidential the additive and VI improver packages it is providing to one of its customers. The customer is selling the oil under its name (as a "rebrand") and will be licensed by API. The oil company proposes, as an alternative to providing all the information to the customer, to provide only a proprietary code for the additive and VI improver packages—which will mask the name of the additive manufacturer. Thus, the customer will receive the ACC candidate data package with coded data. Can the customer be licensed by API under these circumstances?

Answer: Yes, the customer can be licensed.

What API does require for licensing is a "YES" attestation in the block related to the line "ACC Petroleum Additives Panel Product Approval Code of Practice" on Part B of the application form (This "YES" attestation is required for "S" Category and ILSAC licensed oils only, at the present time.)

As an API licensee, the customer can receive from API an inquiry about any oil which it has licensed. It is possible that as a result of a monitoring or enforcement inquiry API will request of the licensee certain information which might include information on the VI Improver, for example. In that case the licensee would be required to provide to API, as specified in the license agreement, all necessary information to satisfy the monitoring or enforcement request.

Licensing Clarification: March 31, 1993

Question: The API Application for Licensure form includes spaces for several oil brands and viscosities. It is assumed that alternate brand names for the same oil (and the same viscosity) are acceptable for inclusion on this form.

Answer: Each product, defined as a separate brand or viscosity grade, requires a separate PART B in the Application for Licensure package. The purpose of this requirement is to insure that oils selected from the market for analysis in API's aftermarket audit program can be identified and matched with the data presented for licensing. For example, if the same oil (SAE viscosity grade) is packaged under the label XYZ as well as another label ABC, they are separate oils for purposes of licensing and should be submitted as separate candidates for licensing.

Licensing Clarification: March 31, 1993

Question: Once the Application Form has been submitted and the license obtained, is it possible to change or modify a brand name? Or does a new Application Form and a further administration fee need to be paid?

Answer: If a licensee desires to change or modify a brand name for a specific product, a new Part B must be completed and submitted to API for approval. No additional fees are required.

Licensing Clarification: June 30, 1993

Question: API licenses two marks. What is the correct way to refer to these marks which are identified in API 1509, as ". . . the API Service Symbol and the ILSAC Certification Mark." (Section 5.1) Our company wishes to advertise these marks to both our retail and bulk customers. However, "ILSAC" and "Service Symbol" have no meaning for most customers. What other labelling or identifying terminology are we permitted to use when referring to the marks?

Answer: Section 5.1 specifies the official names of the two marks.

Licensing Clarification: June 30, 1993

Question: We wish to license a product but to market it under more than one name. For example, we plan to market a single formulation in a number of different geographical locations. How should we proceed?

Answer: The EOLCS aftermarket audit program will match the data obtained from an analysis of marketplace samples with the data submitted to API for licensing, for the same formulation. The brand name is one of the elements required to make the match. Therefore, the name of each brand must be available to API. You should submit a separate Part B for each brand.

Licensing Clarification: November 15, 1993

Question: May the words “Energy Conserving” or “Energy Conserving II” or “API Service” be translated into a foreign language within the API Service Symbol (donut).

Answer: No.

Licensing Clarification: April 16, 2001

Question: Can an API engine oil licensee prepackage API Service Category SL products with API SL in the Service Symbol “donut” in advance of the July 1, 2001 date of first licensing? The licensee understands API SL products cannot be offered for sale before the July 1 date, but it would like to have products ready for sale on that date.

Answer: Yes, a marketer may package products displaying API SL in the API Service Symbol before July 1, 2001, but those products cannot be offered for sale before July 1. This assumes the marketer has completed all necessary API licensing requirements.

Annex Q

ILSAC Minimum Performance Standards for Passenger Car Engine Oils

Q.1 ILSAC GF-1 Minimum Performance Standard for Passenger Car Engine Oils (Obsolete August 1, 1997)

Q.1.1 Introduction

The American Automobile Manufacturers Association, Inc. (AAMA) and the Japan Automobile Manufacturers Association, Inc. (JAMA), through an organization called the International Lubricant Standardization and Approval Committee (ILSAC), jointly developed and approved the GF-1 minimum performance standard for gasoline-fueled passenger car motor oils.

This standard includes only the performance requirements and chemical and physical properties of those engine oils that vehicle manufacturers may deem necessary for satisfactory equipment life and performance. It is the oil marketer's responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information and to conduct its business in a manner that represents minimum risk to consumers and the environment.

This ILSAC minimum performance standard, including all of the additional requirements outlined in Section 4, comprises the first ILSAC standard for passenger car engine oils. Diesel engine oils are not covered in this specification but may be the topic of future discussions between ILSAC and groups representing diesel engine builders.

Q.1.2 Summary

The ILSAC GF-1 standard is composed of five parts. The first section on viscosity uses the Society of Automotive Engineers (SAE) Engine Oil Viscosity Classification, SAE J300. The second section encompasses the American Petroleum Institute (API) SH performance requirements. The third section contains specifications for bench test performance parameters, such as volatility, foaming tendency, high-temperature/high-shear rate viscosity, and filterability. The fourth section contains additional requirements including fuel efficiency, catalyst compatibility, and low-temperature viscosity. Key reference documents are listed in the final section.

The truest evaluation of an engine oil product is satisfactory performance in a variety of vehicle fleet tests that simulate the full range of customer driving conditions. The engine sequence tests listed in this document have been specified instead of fleet testing to minimize testing time and costs. This simplification of test requirements is only possible because the specified engine sequence tests have been correlated to a variety of vehicle tests.

The correlation between engine sequence tests and fleet tests is judged valid based only on the range of base oils, refining processes and additive technologies that have demonstrated satisfactory performance in widespread use at the time this standard was first issued October 22, 1990, and revised October 12, 1992. The introduction of base oils, refining processes or additive technologies that constitute a significant departure from existing practice would require supporting fleet test data and appropriate ASTM engine tests to validate the correlation between the fleet tests and engine sequence tests for that different base oil, refining process, or additive technology. This fleet testing would be in addition to the other requirements listed in this specification.

It is the responsibility of any individual or organization introducing a new technology that they claim will provide equivalent or better performance to ensure their engine test results still correlate with customer field service. Also, the marketer must ensure there is no adverse effect to vehicle components or emission control systems. No marketer can claim to be acting in a reasonable and prudent manner if the marketer knowingly uses a new technology based only on the results of engine sequence testing without verifying suitability in vehicle fleet testing that simulates the full range of customer operation.

Q.1.3 Minimum Performance Standard

The ILSAC GF-1 minimum performance standard is shown in Table Q-1.

Q.1.3.1 Section 1

The first section of the standard deals with viscosity. It utilizes the most widely accepted definition of viscosity, SAE J300. Table Q-1 specifies the latest revision of this document, in order to keep the ILSAC standard current.

Q.1.3.2 Section 2

The second section of the standard defines ASTM engine tests and corresponding requirements used to define API SH Category engine oil performance (see 2.3.2.3 and ASTM D4485). The American Society for Testing and Materials (ASTM) Sequence IID test is used to define the low-temperature rust and corrosion protection provided by engine oils. High-temperature valve train wear, oil thickening, and deposits are evaluated in the ASTM Sequence IIIE test. Low- to medium-temperature sludge and wear are determined in the ASTM Sequence VE test. The L-38 test method defines the bearing corrosion protection provided by engine oils. The 1H2 or 1G2 test that defined piston cleanliness was dropped from the October 22, 1990, version of this standard because of concern over interpretation of test results. A replacement test is being sought to evaluate high-temperature deposit formation.

Table Q-1—ILSAC GF-1 Passenger Car Engine Oil Minimum Performance Standard (Obsolete August 1, 1997)

Requirement	Criterion
Viscosity Requirements	As defined by the most recent revision of SAE Standard J300
Engine Test Requirements	As defined by the most recent revision of ASTM D4485
Engine rusting	ASTM D5844 Sequence IID test
Average rust rating	8.5 (min)
Stuck lifters	None
Wear and oil thickening	ASTM D5533 Test Method Sequence IIIE
Increase in viscosity at 40°C	375% (max)
Piston skirt varnish	8.9 (min)
Ring land deposits	3.5 (min)
Average engine sludge	9.2 (min)
Stuck piston rings	No oil related
Cam and lifter wear	
Average, mm	30 (max)
Maximum, mm	64 (max)
Oil consumption, l	5.1 (max)
Sludge and wear	ASTM D5302 Test Method Sequence VE
Average engine sludge	9.0 (min)
Rocker cover sludge	7.0 (min)
Average engine varnish	5.0 (min)
Piston skirt varnish	6.5 (min)
Cam wear	
Average, mm	130 (max)
Maximum, mm	380 (max)
Oil ring clogging[a]	15% (max)
Oil screen clogging	20% (max)
Hot-stuck rings	None
Bearing corrosion	ASTM D5119 Test Method L-38
Bearing weight loss, mg	40 (max)
Piston skirt varnish	9.0 (min)

Table Q-1—ILSAC GF-1 Passenger Car Engine Oil Minimum Performance Standard (Continued)
(Obsolete August 1, 1997)

Requirement	Criterion
Bench Test Requirements	
HTHS viscosity at 150°C and 106 s–1	ASTM D4683, ASTM D4741, or CEC L-36-A-90
For all viscosity grades, mPa • S	2.9 (min)
Volatility	Sim. dis. (ASTM D2887) or evaporative loss (CEC L-40-A-93)
ASTM D2887	20% (max) at 371°C (0W, 5W multigrades)
	17% (max) at 371°C (all other multigrades)
CEC L-40-A-93	25% (max) 1 hr at 250°C (0W, 5W multigrades)
	20% (max) 1 hr at 250°C (all other multigrades)
Filterability	
GM 9099P EOFT	50% (max) flow reduction
Foaming tendency	ASTM D892 (Option A)
Foaming, ml	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Sequence IV	Report
Settling[b], ml	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
Sequence IV	Report
Flash point	ASTM D93 or D 92
ASTM D93	185°C (min)
ASTM D92	200°C (min)
Shear stability	
L-38 test 10-hour stripped viscosity	Must remain in original SAE viscosity grade
Homogeneity and miscibility	
Federal Test Method 791B, Method 3470	Shall remain homogenous and, when mixed with SAE reference oils, shall remain miscible

Table Q-1—ILSAC GF-1 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete August 1, 1997)

Additional Requirements			
Fuel efficiency			
ASTM RR-D:2-1204 Sequence VI Test improvement (EFEI)	2.7% (min)		
Catalyst compatibility			
Phosphorus content	0.12 mass % (max)		
SAE J300 low-temperature viscosity, mPa•S	0W	5W	10W
Cranking	3,250 at -30°C (max)	3,500 at -25°C (max)	3,500 at -20°C (max)
Pumping	30,000 at -35°C (max)	30,000 at -30°C (max)	30,000 at -25°C (max)

Notes:
[a]Effective October 8, 1993, the Oil Ring Clogging parameter has been suspended as a requirement for the Sequence VE test. Therefore, it has been removed as a requirement for licensing. For any programs that include more than one Sequence VE test and the test completion dates include dates both before and after October 8, 1993, Oil Ring Clogging should be ignored for these tests. ASTM re-evaluated this issue in June 1994 and decided to suspend this parameter indefinitely.
[b]Settling determined after 5 minutes, except Sequence IV, in which settling is determined after 5 seconds. Sequence IV test conditions are the same as those in Sequence I, except that the temperature is 150°C and the minimum flow rate is 200 milliliters.

Q.1.3.3 Section 3

The bench test requirements are outlined in Section 3. High-temperature, high-shear-rate viscosity provides an estimate of bearing oil film thickness and, thus, relates to bearing life [1]. A value of 2.9 mPa•S at 150°C and 1 million seconds–1 is considered by AAMA and JAMA members to provide adequate assurance of bearing durability in passenger car engines.

Volatility, as measured by either the NOACK or ASTM simulated distillation method, is included in the standard because volatility has been shown to correlate with oil consumption in the field [2, 3]. The values were selected to provide acceptable oil economy in the field. The higher allowable volatility values specified for the lighter viscosity grade oils are an acknowledgment of the difficulties encountered with existing refining equipment and/or processes when manufacturing the lighter base stocks necessary for such oils. There is a real need to improve this limit over time, and base oil manufacturers should make plans to modify equipment and/or processes to satisfy future requirements that will likely be more stringent.

A filterability test is incorporated in the standard to ensure the water tolerance of oils under low-temperature conditions. The limits in the General Motors Engine Oil Filterability Test (GM 9099P) correspond to GM's and Ford's initial fill requirements. ASTM has been requested to standardize this test and to consider having the ASTM Test Monitoring Center handle distribution of reference oils and filter paper. This would provide worldwide availability of the test method and test materials.

ASTM Foam Test (D 892) limits similar to Ford and General Motors' initial fill and U.S. military specifications are incorporated in the ILSAC standard to ensure that foaming will not be a problem in current and future engines, which tend to run at higher speeds and sometimes incorporate balance shafts, both of which can promote foaming. The Sequence IV portion of this test, although not formally part of the ASTM procedure yet, is believed to correlate better with foaming under high-speed engine operating conditions. The intent of including the Sequence IV portion of this test as a report-only item is to gather data on this procedure so that, after it has become an ASTM standard, it can be added to the ILSAC standard with an appropriate maximum acceptable limit.

Two alternative flash point methods are also included in the standard, primarily to cover safety and materials handling concerns.

A shear stability requirement for the 10-hour oil sample from the L-38 test to remain within the original SAE viscosity grade is also included. An investigation into alternative shear stability methods will be conducted for possible use in future standards.

Requirements for homogeneity and miscibility are included in the standard primarily as quality control checks, to ensure that the oil is blended properly (i.e., that the additives have not settled out).

Q.1.3.4 Section 4

Section 4 of the ILSAC standard incorporates additional requirements. All three of the additional requirements listed in Section 4 must be met in order for an oil to satisfy the licensing requirements of the API Certification Mark in the API Engine Oil Licensing and Certification System (EOLCS). The fuel efficiency requirement is important since widespread use of engine oils providing at least a 2.7 percent fuel economy improvement in the ASTM Sequence VI test could provide fuel savings in the country as a whole as compared to what the situation would be if other oils were used, although the fuel economy obtained by individual vehicle operators may differ because of many factors.

No currently acceptable standard test exists for determining the catalyst poisoning effect of engine oils. In the absence of such a test, and since it has been shown that engine-oil-derived phosphorus poisons emission control devices [4], it is believed prudent to limit the phosphorus content of the engine oil to 0.12 mass percent maximum.

The last portion of Section 4 of the standard deals with the low-temperature viscosity of engine oils, as defined by SAE J300. The low-temperature viscometric properties of multiviscosity grade engine oils are important as they relate to cold starting performance in gasoline-fueled passenger cars.

Q.1.3.5 Section 5

Section 5 of the standard references procedures for conducting the tests included in the standard.

References

1. Spearot, J. A.; Murphy, C. K.; and Deysarkar, A. K.; “Interpreting Experimental Bearing Oil Film Thickness Data” (Paper No. 892151), Society of Automotive Engineers, Warrendale, Pennsylvania.

2. Didot, F. E.; Green, E.; and Johnson, R. H.; “Volatility and Oil Consumption of SAE 5W-30 Engine Oil” (Paper No. 872126), Society of Automotive Engineers, Warrendale, Pennsylvania.

3. Carey, L. R.; Roberts, D. C.; and Shaub, H.; “Factors Influencing Engine Oil Consumption in Today’s Automotive Engines” (Paper No. 892159), Society of Automotive Engineers, Warrendale, Pennsylvania.

4. SAE Fuels and Lubricants Technical Committee 1, *Engine Oil/Catalyst and Oxygen Sensor Compatibility Task Force Status Report*, Society of Automotive Engineers, Warrendale, Pennsylvania, October 1985.

Q.2 ILSAC GF-2 Minimum Performance Standard for Passenger Car Engine Oils (Obsolete March 31, 2002)

The American Automobile Manufacturers Association of the United States, Inc. (AAMA) and the Japan Automobile Manufacturers Association, Inc. (JAMA), through an organization called the International Lubricants Standardization and Approval Committee (ILSAC), jointly developed and approved an ILSAC GF-2 minimum performance standard for gasoline-fueled passenger car engine oils.

This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for those engine oils that vehicle manufacturers deem necessary for satisfactory equipment performance and life.

In addition to meeting the requirements of the standard as shown in Table Q-2, it is the oil marketer’s responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information when marketing products meeting the GF-2 standard. It is also the marketer’s responsibility to conduct its business in a manner that represents minimum risk to consumers and the environment.

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

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

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

The ILSAC GF-2 Minimum Performance Standard includes the new Sequence VIA test. Viscosity Grade Read Across and Base Oil Interchange Guidelines have been developed specifically for the Sequence VIA test. These guidelines will be reviewed and, if appropriate, updated by API with the approval of AAMA. The current guidelines can be applied for viscosity grade read across and base oil interchange in the Sequence IID, IIIE, and VE and L-38 tests. API has been requested to continue to solicit and review data confirming the applicability of these guidelines to GF-2 oils. Oil marketers use the above guidelines at their own judgment and at their own risk. The use of these guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-2 with API.

Note: This paragraph has been updated since the ILSAC GF-2 Minimum Performance Standard was issued November 6, 1995.

Table Q-2—ILSAC GF-2 Passenger Car Engine Oil Minimum Performance Standard (Obsolete March 31, 2002)

Requirement	Criterion	
Viscosity Requirements	Viscosity, mPa•S, at Temperature, °C	
	Cranking:	Pumping:
	ASTM D5293	ASTM D4684
	3500 (max) at – 20°C	60,000 (max) at – 30°C
	Gelation Index ASTM D5133: • 12.0 (max) • To be evaluated from – 5°C to temperature at which 40,000 cP is attained or – 40°C, whichever occurs first	
	Other Requirements: As defined by the latest revision of SAE Standard J300	

Table Q-2—ILSAC GF-2 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete March 31, 2002)

Requirement	Criterion
Engine Test Requirements	As defined by the most recent revision of ASTM D4485
Engine rusting	ASTM D5844 Sequence IID test
Average rust rating	8.5 (min)
Stuck lifters	None
Wear and oil thickening	ASTM D5533 Test Method Sequence IIIE
Hours to 375% increase In viscosity @ 40°C	64 (min)
Piston skirt varnish	8.9 (min)
Ring land deposits	3.5 (min)
Average engine sludge	9.2 (min)
Stuck piston rings	No oil related
Cam and lifter wear	
Average, mm	30 (max)
Maximum, mm	64 (max)
Oil consumption, l	5.1 (max)
Sludge and wear	ASTM D5302 Test Method Sequence VE
Average engine sludge	9.0 (min)
Rocker cover sludge	7.0 (min)
Average engine varnish	5.0 (min)
Piston skirt varnish	6.5 (min)
Cam wear	
Average, mm	127 (max)
Maximum, mm	380 (max)
Oil screen clogging	20% (max)
Hot-stuck rings	None
Piston undercrown deposits	Rate and report
Ring land deposits	Rate and report
Cylinder bore wear	Rate and report
Oil ring clogging	Rate and report
Bearing corrosion	ASTM D5119 Test Method L-38
Bearing weight loss, mg	40 (max)
Fuel economy improvement (FEI)	ASTM D6202 Sequence VIA Test For SAE 0W-20 and 5W-20 viscosity grades: 1.4% (min) vs. ASTM BC-2 For other SAE 0W and 5W multi-viscosity grades: 1.1% (min) vs. ASTM BC-2 For all SAE 10W multi-viscosity grades: 0.5% (min) vs. ASTM BC-2

Table Q-2—ILSAC GF-2 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete March 31, 2002)

Requirement	Criterion
Bench Test Requirements	
Volatility	Simulated distillation (ASTM D2887 extended) or (ASTM D5480) 17% (max) at 371°C - or - Evaporative loss (CEC L-40-A-93) or JPI 5S-41-93 (Method B) 22% (max), 1 h at 250°C
Filterability	GM 9099P EOFT 50% (max) flow reduction allowable GM EOFT with following modifications (Rate and Report only): 1. Dry ice is not to be used during sample preparation. 2. Sample is to be placed in oven at 70°C for 6.0 hours (±0.25 hours). 3. Tests to be run at 0.6, 1.0, 2.0, and 3.0% water. 4. Test formulation with the highest additive (DI/VI) combination. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different (DI/VI) combination must be tested.
Foaming tendency	ASTM D892 (Option A)
Foaming, ml	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Settling[a] ml	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
High temperature foaming[b]	
Static foam max, tendency/stability	200/50[c]
Flash point	ASTM D93 (ISO 2719) or ASTM D92
ASTM D93 (ISO 2719)	185°C (min)
ASTM D92	200°C (min)
Shear stability	
L-38 test 10-hour stripped viscosity	Must remain in original SAE viscosity grade
Homogeneity and miscibility Federal Test Method 791B, Method 3470	
Additional Requirements:	
High temperature deposits	ASTM D6335
Chrysler TEOST Test (Method 33)	60 mg deposit (max)
Catalyst Compatibility	
Phosphorus Content	

[a]Settling determined after 10 minutes.
[b]Follow High Temperature Foam Test in ASTM D6082.
[c]Settling determined after 1 minute.

Q.3 ILSAC GF-3 Minimum Performance Standard for Passenger Car Engine Oils (Obsolete April 30, 2004)

The Japan Automobile Manufacturers Association, Inc. and representatives from DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation, through an organization called the International Lubricant Standardization and Approval Committee (ILSAC), jointly developed and approved an ILSAC GF-3 minimum performance standard for gasoline-fueled passenger car engine oils.

This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for those engine oils that vehicle manufacturers deem necessary for satisfactory equipment performance and life.

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

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

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

Engine oil compatibility with sealing materials and gaskets is not controlled by performance tests in this specification. However, an SAE Committee on Automotive Rubber Specifications (CARS) has established a slate of reference elastomers that may be used for testing of different base oils and additive technologies that constitute a significant departure from existing materials. The CARS committee has also established an ASTM reference oil (TMC1006) that should be considered as an aggressive oil and could also be used as a reference. ILSAC recommends that additive or base oil technologies that exceed the aggression of this reference oil be revised or adequately field tested to ensure no chance of customer seal failures when placed in commercial service.

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

The ILSAC GF-3 Minimum Performance Standard includes the new Ball Rust Test, the new Sequence IIIF test, the new Sequence IVA test, the new Sequence VG test, the new Sequence VIB test, the new Sequence VIII test, and the new TEOST MHT test. Viscosity grade read across and base oil interchange for these tests may be applicable after VGRA and BOI Guidelines for them are supported by test data and developed by the appropriate groups. It should be pointed out, however, that when oil marketers use the guidelines, they do so based on their own judgment and at their own risk. The use of these guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-3 with API.

Table Q-3—ILSAC GF-3 Passenger Car Engine Oil Minimum Performance Standard (Obsolete April 30, 2004)

Requirement	Criterion
Viscosity Requirements	Oils shall meet all requirements of SAE J300 and low temperature requirements of either SAE 0W, 5W or 10W viscosity grades Gelation Index ASTM D5133: • 12.0 (max) • To be evaluated from –5°C to temperature at which 40,000 cP is attained or –40°C, whichever occurs first

Table Q-3—ILSAC GF-3 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete April 30, 2004)

Requirement	Criterion
Engine Test Requirements	As defined by the most recent revision of ASTM D4485
Engine rusting	ASTM Ball Rust Test
Average rust rating	100 (min)
Wear and oil thickening	ASTM Sequence IIIF Test
Viscosity increase (kV 40°C)	275% (max)
Low temp viscosity	Report[a]
Average piston skirt varnish rating	9.0 (min)
Weighted piston deposit rating	4.0 (min)
Hot stuck piston rings	None allowed
Cam plus lifter wear, average, mm	20 (max)
Oil consumption, l	5.2 (max)
Cam wear	ASTM Sequence VE Test[b]
Average, mm	127 (max)
Maximum, mm	380 (max)
Sludge and varnish	ASTM Sequence VG Test
Average engine sludge rating	7.8 (min)
Rocker cover sludge rating	8.0 (min)
Average engine varnish rating	8.9 (min)
Average piston skirt varnish rating	7.5 (min)
Oil screen clogging,%	20 (max)
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil screen debris,%	Rate and report
Oil ring clogging	Rate and report
Valvetrain wear	ASTM Sequence IVA Test
Average cam wear (7 position avg.), mm	120 (max)
Bearing corrosion	ASTM Sequence VIII Test
Bearing weight loss, mg	26.4 (max)
Fuel economy improvement (FEI)	ASTM Sequence VIB Test[c] For SAE 0W-20 and 5W-20 viscosity grades: 2.0% FEI 1 (min) after 16 hours aging 1.7% FEI 2 (min) after 96 hours aging For SAE 0W-30 and 5W-30 viscosity grades: 1.6% FEI 1 (min) after 16 hours aging 1.3% FEI 2 (min) after 96 hours aging Sum of FEI 1 and FEI 2 must be 3.0% (min) For SAE 10W-30 and all other viscosity grades not listed above: 0.9% FEI 1 (min) after 16 hours aging 0.6% FEI 2 (min) after 96 hours aging Sum of FEI 1 and FEI 2 must be 1.6% (min)

Table Q-3—ILSAC GF-3 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete April 30, 2004)

Requirement	Criterion
Bench Test Requirements	As defined by the most recent revision of ASTM D4485
Volatility	
Evaporation loss	ASTM D5800 15% (max), 1 hour at 250°C
Simulated distillation	ASTM D6417 10% (max) at 371°C
High temperature deposits	TEOST MHT-4
Deposit weight, mg	45 (max)
Filterability	
Engine oil filterability test (EOFT)	50% (max) flow reduction allowable
Engine oil water tolerance test (EOWTT)	50% (max) flow reduction allowable 1. Dry ice not to be used during sample preparation. 2. Sample to be placed in oven at 70°C for 6 hours (±0.25 hours). 3. Tests to be run at 0.6, 1.0, 2.0 and 3.0% H2O. 4. Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.
Foaming tendency	ASTM D892 (Option A)
Foaming, ml	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
After settling[d], ml	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
High temperature foaming	ASTM D6082 (optional blending required)
Foaming, ml	100 (max)
After settling[e], ml	0 (max)
Shear stability	ASTM Sequence VIII Test
10-hour stripped 100°C kinematic viscosity	Must remain in original SAE viscosity grade
Homogeneity and miscibility	ASTM D6922, Method 3470.1 Shall remain homogeneous and, when mixed with SAE reference oils, shall remain miscible
Catalyst compatibility	ASTM D4951 or D5185
Phosphorus content	0.10 mass % (max)

[a]80-hour test oil sample shall be evaluated by ASTM Test Method D 4684 (MRV TP-1) at the temperature indicated by the low-temperature grade of oil as determined on the 80-hour sample by ASTM Test Method D 5293 (CCS viscosity).
[b]Not required for oils containing a minimum of 0.08% phosphorus in the form of zinc dialkyldithiophosphates (ZDDP).
[c]All FEI 1 and FEI 2 values determined relative to ASTM Reference Oil BC.
[d]Settling determined after 10 minutes.
[e]Settling determined after 1 minute.

Q.4 ILSAC GF-4 Minimum Performance Standard for Passenger Car Engine Oils (Obsolete September 30, 2011)

The Japan Automobile Manufacturers Association, Inc. and representatives from DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation, through an organization called the International Lubricants Standardization and Approval Committee (ILSAC), jointly developed and approved an ILSAC GF-4 minimum performance standard for gasoline-fueled passenger car engine oils.

This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for those engine oils that vehicle manufacturers deem necessary for satisfactory equipment performance and life.

In addition to meeting the requirements of the standard, it is the oil marketer's responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information when marketing products meeting the GF-4 standard. It is also the marketer's responsibility to conduct its business in a manner which represents minimum risk to consumers and the environment.

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

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

Engine oil compatibility with sealing materials and gaskets is not controlled by performance tests in this specification. However, an SAE Committee on Automotive Rubber Specifications (CARS) has established a slate of reference elastomers (see SAE J2643) which may be used for testing of different base oils and additive technologies which constitute a significant departure from existing materials. The CARS committee has also established an ASTM reference oil (Service Oil 105) which should be considered as an aggressive oil and could also be used as a reference. ILSAC recommends that additive or base oil technologies that exceed the aggression of this reference oil be revised or adequately field tested to ensure no chance of customer seal failures when placed in commercial service.

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

The ILSAC GF-4 Minimum Performance Standard includes tests for which Viscosity Grade Read Across and Base Oil Interchange Guidelines have been developed by the appropriate groups. It should be pointed out, however, that when oil marketers use the Guidelines, they do so based on their own judgment and at their own risk. The use of any guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-4 with API.

Table Q-4—ILSAC GF-4 Passenger Car Engine Oil Minimum Performance Standard (Obsolete September 30, 2011)

Requirement	Criterion
Fresh Oil Viscosity Requirements	
SAE J300	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W, 5W, and 10W multigrade oils.
Gelation index	ASTM D5133 12 (max) To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.
Engine Test Requirements	
Wear and oil thickening	ASTM Sequence IIIG
Kinematic viscosity increase @ 40°C, %	150 (max)
Average weighted piston deposits, merits	3.5 (min)
Hot stuck rings	None
Average cam plus lifter wear, µm	60 (max)
Aged oil low temperature viscosity	ASTM Sequence IIIGA
Evaluate the EOT oil from the ASTM Sequence IIIGA test with ASTM D4684 (MRV TP-1)	The ASTM D4684 viscosity of the EOT sample must meet the requirements of the original grade or the next higher grade
Wear, sludge, and varnish	ASTM Sequence VG (ASTM D6593)
Average engine sludge, merits	7.8 (min)
Average rocker cover sludge, merits	8.0 (min)
Average engine varnish, merits	8.9 (min)
Average piston skirt varnish, merits	7.5 (min)
Oil screen sludge, % area	20 (max)
Oil screen debris, % area	Rate and report
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil ring clogging, % area	Rate and report
Follower pin wear, cyl #8, avg, µm	Rate and report[a]
Ring gap increase, cyl #1 and #8, avg, µm	Rate and report[a]
Valvetrain wear	ASTM Sequence IVA (ASTM D6891)
Average cam wear (7 position avg.), µm	90 (max)
Bearing corrosion	ASTM Sequence VIII (ASTM D6709)
Bearing weight loss, mg	26 (max)
Fuel efficiency	ASTM Sequence VIB[b] (ASTM D6837) SAE 0W-20 and 5W-20 viscosity grades: 2.3% FEI 1 (min) after 16 hours aging 2.0% FEI 2 (min) after 96 hours aging SAE 0W-30 and 5W-30 viscosity grades: 1.8% FEI 1 (min) after 16 hours aging 1.5% FEI 2 (min) after 96 hours aging SAE 10W-30 and all other viscosity grades not listed above: 1.1% FEI 1 (min) after 16 hours aging 0.8% FEI 2 (min) after 96 hours aging

[a]ASTM Surveillance Panel will review statistics annually.
[b]All Fuel Economy Improvement (FEI) 1 and FEI 2 values determined relative to ASTM Reference Oil BC.

Table Q-4—ILSAC GF-4 Passenger Car Engine Oil Minimum Performance Standard (Continued)
(Obsolete September 30, 2011)

Requirement	Criterion
Bench Test Requirements	
Catalyst compatibility	
Phosphorus content, % (mass)	ASTM D4951 0.08 (max)
Sulfur content	ASTM D4951 or D 2622
SAE 0W and 5W multigrades, % (mass)	0.5 (max)
SAE 10W multigrades, % (mass)	0.7 (max)
Wear	ASTM D4951
Phosphorus content, % (mass)	0.06 (min)
Volatility	ASTM D5800
Evaporation loss, %	15 (max), 1 hour at 250°C (Note: Calculated conversions specified in D 5800 are allowed.)
Simulated distillation, %	ASTM D6417 10 (max) at 371°C
High temperature deposits	TEOST MHT
Deposit weight, mg	35 (max)
Filterability	
EOWTT, %	ASTM D6794
with 0.6% H_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	50 (max) flow reduction (Note: Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.)
EOFT, %	ASTM D6795 50 (max) flow reduction
Foaming characteristics	ASTM D892 (Option A)
Tendency, mL	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Stability[c], mL	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
High temperature foaming characteristics	ASTM D6082 (Option A)
Tendency, mL	100 (max)
Stability[d], mL	0 (max)
Shear stability	ASTM Sequence VIII (ASTM D6709)
10-hour stripped KV @ 100°C	Kinematic viscosity must remain in original SAE viscosity grade.

[c]After 10-minute settling period.
[d]After 1-minute settling period.

Table Q-4—ILSAC GF-4 Passenger Car Engine Oil Minimum Performance Standard (Continued) (Obsolete September 30, 2011)

Requirement	Criterion
Bench Test Requirements (continued)	
Homogeneity and miscibility	ASTM D6922 Shall remain homogeneous and, when mixed with ASTM reference oils, shall remain miscible.
Engine rusting	Ball Rust Test (ASTM D6557)
Average gray value	100 (min)

Applicable Documents:

1. SAE Standard, Engine Oil Viscosity Classification—SAE J300, *SAE Handbook*.
2. SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5—SAE J2643, *SAE Handbook*.
3. ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.
4. ASTM Sequence IIIG Test Research Report.
5. M. Batko and D. F. Florkowski, “Low Temperature Rheological Properties of Aged Crankcase Oils,” SAE Paper 2000-01-2943.
6. M. Batko and D. F. Florkowski, “Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine,” SAE Paper 01FL-265

Q.5 ILSAC GF-5 Standard for Passenger Car Engine Oils (Effective October 1, 2010)

The Japan Automobile Manufacturers Association, Inc. and representatives from Chrysler Group LLC, Ford Motor Company and General Motors LLC, through an organization called the International Lubricants Standardization and Approval Committee (ILSAC), jointly developed and approved an ILSAC GF-5 minimum performance standard for engine oils for spark-ignited internal combustion engines.

This standard specifies the minimum performance requirements (both engine sequence and bench tests) and chemical and physical properties for engine oils for spark-ignited internal combustion engines. It is expected that many engine manufacturers will recommend ILSAC GF-5 oil. However, performance parameters other than those covered by the tests included or more stringent limits on those tests included in this standard may be required by individual OEMs.

In addition to meeting the requirements of the standard, it is the oil marketer's responsibility to be aware of and comply with all applicable legal and regulatory requirements on substance use restrictions, labeling, and health and safety information when marketing products meeting the ILSAC GF-5 standard. It is also the marketer's responsibility to conduct its business in a manner that represents minimum risk to consumers and the environment.

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

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

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

The ILSAC GF-5 Minimum Performance Standard includes tests for which Viscosity Grade Read Across and Base Oil Interchange Guidelines have been developed by the appropriate groups. It should be pointed out, however, that when oil marketers use the guidelines, they do so based on their own judgment and at their own risk. The use of any guidelines does not absolve the marketer of the responsibility for meeting all specified requirements for any products the marketer sells in the marketplace that are licensed as ILSAC GF-5 with API.

Table Q-5—ILSAC GF-5 Passenger Car Engine Oil Standard

Requirement	Criterion
Fresh Oil Viscosity Requirements	
SAE J300	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W, 5W, and 10W multigrade oils
Gelation index	ASTM D5133 12 (max) To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first
High Temperature/High Shear Viscosity @ 150°C, mPa·s	ASTM D4683, D4741, or D5481 2.6 (min)

Table Q-5—ILSAC GF-5 Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Engine Test Requirements	
Wear and oil thickening	ASTM Sequence IIIG (ASTM D7320)
Kinematic viscosity increase @ 40°C, %	150 (max)
Average weighted piston deposits, merits	4.0 (min)
Hot stuck rings	None
Average cam plus lifter wear, µm	60 (max)
Or	Or
Deposit and oil thickening	ASTM Sequence IIIH (ASTM D8111)
Kinematic viscosity increase @ 40°C, %	150 (max)
Average weighted piston deposits, merits	3.7 (min)
Hot stuck rings	None
Wear, sludge, and varnish	ASTM Sequence VG (ASTM D6593)
Average engine sludge, merits	8.0 (min)
Average rocker cover sludge, merits	8.3 (min)
Average engine varnish, merits	8.9 (min)
Average piston skirt varnish, merits	7.5 (min)
Oil screen sludge, % area	15 (max)
Oil screen debris, % area	Rate and report
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil ring clogging, % area	Rate and report
Or	Or
Wear, sludge, and varnish	ASTM Sequence VH (ASTM DXXXX)
Average engine sludge, merits	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)
Oil screen clogging, % area	Rate & report
Hot stuck compression rings	None
Valvetrain wear	ASTM Sequence IVA (ASTM D6891)
Average cam wear (7 position avg), µm	90 (max)
Bearing corrosion	ASTM Sequence VIII (ASTM D6709)
Bearing weight loss, mg	26 (max)
Fuel efficiency	ASTM Sequence VID (ASTM D7589)
SAE XW-20 viscosity grade	
FEI SUM	2.6% min
FEI 2	1.2% min after 100 hours aging
SAE XW-30 viscosity grade	
FEI SUM	1.9% min
FEI 2	0.9% min after 100 hours aging
SAE 10W-30 and all other viscosity grades not listed above	
FEI SUM	1.5% min
FEI 2	0.6% min after 100 hours aging
Or	Or
Fuel efficiency	ASTM Sequence VIE (ASTM D8114)
SAE XW-20 viscosity grade	
FEI SUM	3.2% min
FEI 2	1.5% min after 100 hours aging
SAE XW-30 viscosity grade	
FEI SUM	2.5% min
FEI 2	1.2% min after 100 hours aging
SAE 10W-30 and all other viscosity grades not listed above	
FEI SUM	2.2% min
FEI 2	1.0% min after 100 hours aging

Table Q-5—ILSAC GF-5 Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Bench Test Requirements	
Catalyst compatibility	
Phosphorus content, % (mass)	ASTM D4951 or D5185 0.08 (max)
Phosphorus volatility (Sequence IIIGB, phosphorus retention)	ASTM D7320 79% (min)
Sulfur content	ASTM D4951, D5185, or D2622
SAE 0W and 5W multigrades, % (mass)	0.5 (max)
SAE 10W-30, % (mass)	0.6 (max)
Wear	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.06 (min)
Volatility	ASTM D5800
Evaporation loss, %	15 (max), 1 hour at 250°C (Note: Calculated conversions specified in D5800 are allowed.)
Simulated distillation, %	ASTM D6417 10 (max) at 371°C
High temperature deposits	TEOST MHT (ASTM D7097)
Deposit weight, mg	35 (max)
High temperature deposits	TEOST 33C (ASTM D6335)
Total deposit weight, mg	30 (max) Note: No TEOST 33C limit for SAE 0W-20.
Filterability	ASTM D6794
EOWTT, %	
with 0.6% H_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	50 (max) flow reduction Note: Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.
EOFT, %	ASTM D6795 50 (max) flow reduction
Fresh oil foaming characteristics	ASTM D892 (Option A and excluding paragraph 11)
Tendency, mL	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Stability, mL, after 1-minute settling	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
Fresh oil high temperature foaming characteristics	ASTM D6082 (Option A)
Tendency, mL	100 (max)
Stability, mL, after 1-minute settling	0 (max)

Table Q-5—ILSAC GF-5 Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Bench Test Requirements (continued)	
Aged oil low temperature viscosity Measure CCS viscosity of EOT ROBO sample at CCS temperature corresponding to original viscosity grade	ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to maximum CCS viscosity specified for original viscosity grade, run ASTM D4684 (MRV TP-1) at MRV temperature specified in SAE J300 for original viscosity grade. b) If CCS viscosity measured is higher than maximum viscosity specified for original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for next higher viscosity grade). c) EOT ROBO sample must show no yield stress in D4684 test and its D4684 viscosity must be below maximum specified in SAE J300 for the original viscosity grade or next higher viscosity grade, depending on CCS viscosity grade, as outlined in a) or b) above.
	Or
Aged oil low temperature viscosity	ASTM Sequence IIIGA (ASTM D7320) d) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. e) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). f) EOT IIIGA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.
Shear stability 10-hour stripped KV @ 100°C	ASTM Sequence VIII (ASTM D6709) Kinematic viscosity must remain in original SAE viscosity grade except XW-20 which must remain ≥ 5.6 mm^2/s
Homogeneity and miscibility	ASTM D6922 Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center (TMC) reference oils, shall remain miscible.
Engine rusting Average gray value	Ball Rust Test (ASTM D6557) 100 (min)
Emulsion retention 0°C, 24 hours 25°C, 24 hours	ASTM D7563 No water separation No water separation
Elastomer compatibility	ASTM D7216 Annex A2 Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2. The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed below:

Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

Applicable Documents:

1. SAE Standard, Engine Oil Viscosity Classification—SAE J300, *SAE Handbook*.
2. SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5—SAE J2643, *SAE Handbook*.
3. ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.
5. M. Batko and D. F. Florkowski, “Low Temperature Rheological Properties of Aged Crankcase Oils,” SAE Paper 2000-01-2943.
6. M. Batko and D. F. Florkowski, “Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine,” SAE Paper 01FL-265

Q.6 ILSAC GF-6A/GF-6B Standard for Passenger Car Engine Oils (Effective May 1, 2020)

The Japan Automobile Manufacturers Association, Inc. and representatives from Fiat Chrysler Automobiles, Ford Motor Company, and General Motors LLC, through an organization called the International Lubricants Standardization Advisory Committee (ILSAC), jointly developed and approved the ILSAC GF-6A and GF-6B minimum performance standards for engine oils for spark-ignited internal combustion engines (see Tables Q-6 and Q-7).

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

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

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

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

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

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

Table Q-6A—ILSAC GF-6A Passenger Car Engine Oil Standard

Requirement	Criterion
Fresh Oil Viscosity Requirements	
SAE J300	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 multigrade oils
Gelation index	ASTM D5133 12 (max) To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first
Engine Test Requirements	
Wear and oil thickening	ASTM Sequence IIIH (ASTM D8111)
Kinematic viscosity increase @ 40°C, %	100 (max)
Average weighted piston deposits, merits	4.2 (min)
Hot stuck rings	None
Wear, sludge, and varnish	ASTM Sequence VH (ASTM DXXXX)
Average engine sludge, merits	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)
Oil screen sludge, % area	Rate and report
Oil screen debris, % area	Rate and report
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil ring clogging, % area	Rate and report
Valvetrain wear	ASTM Sequence IVB (ASTM DXXXX)
Average intake lifter volume loss (8 position avg), mm^3	2.7 (max)
End of test iron, ppm	400 (max)
Bearing corrosion	ASTM Sequence VIII (ASTM D6709)
Bearing weight loss, mg	26 (max)
Fuel efficiency	ASTM Sequence VIE (ASTM D8114)
SAE XW-20 viscosity grade	
FEI SUM	3.8% min
FEI 2	1.8% min after 125 hours aging
SAE XW-30 viscosity grade	
FEI SUM	3.1% min
FEI 2	1.5% min after 125 hours aging
SAE 10W-30 viscosity grade	
FEI SUM	2.8% min
FEI 2	1.3% min after 125 hours aging
Low-speed preignition prevention	ASTM Sequence IX (ASTM DXXXX)
Average number of events for four iterations	5 (max)
Number of events per iteration	8 (max)
Chain wear	ASTM Sequence X (ASTM DXXXX)
Percent increase	0.085 (max)

Table Q-6A—ILSAC GF-6A Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Bench Test Requirements	
Catalyst compatibility	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.08 (max)
Phosphorus volatility (Sequence IIIHB, phosphorus retention)	ASTM D7320 81% (min)
Sulfur content	ASTM D4951, D5185, or D2622
SAE 0W and 5W multigrades, % (mass)	0.5 (max)
SAE 10W-30, % (mass)	0.6 (max)
Wear	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.06 (min)
Volatility	ASTM D5800 (B&D)
Evaporation loss, %	15.0 (max), 1 hour at 250°C
High temperature deposits	TEOST 33C (ASTM D6335)
Total deposit weight, mg	30 (max) Note: No TEOST 33C limit for SAE 0W-20.
Filterability	ASTM D6794
EOWTT, %	
with 0.6% H_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	50 (max) flow reduction Note: Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.
EOFT, %	ASTM D6795 50 (max) flow reduction
Fresh oil foaming characteristics	ASTM D892 (Option A and excluding Section 11 Alternative Procedure)
Tendency, mL	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Stability, mL, after 1-minute settling	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
Fresh oil high temperature foaming characteristics	ASTM D6082 (Option A)
Tendency, mL	100 (max)
Stability, mL, after 1-minute settling	0 (max)

Table Q-6A—ILSAC GF-6A Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above. Or
Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	ASTM Sequence IIIHA (ASTM D8111) d) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. e) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). f) EOT IIIHA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.
Shear stability 10-hour stripped KV @ 100°C XW-20 XW-30	ASTM Sequence VIII (ASTM D6709) Stay in grade Stay in grade
Homogeneity and miscibility	ASTM D6922 Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center (TMC) reference oils, shall remain miscible.
Engine rusting Average gray value	Ball Rust Test (ASTM D6557) 100 (min)
Emulsion retention 0°C, 24 hours 25°C, 24 hours	ASTM D7563 No water separation No water separation
Elastomer compatibility	ASTM D7216 Annex A2 Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2. The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed below:

Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

Applicable Documents:

1. SAE Standard, Engine Oil Viscosity Classification—SAE J300, *SAE Handbook*.
2. SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5—SAE J2643, *SAE Handbook*.
3. ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.
5. M. Batko and D. F. Florkowski, “Low Temperature Rheological Properties of Aged Crankcase Oils,” SAE Paper 2000-01-2943.
6. M. Batko and D. F. Florkowski, “Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine,” SAE Paper 01FL-265

Table Q-6B—ILSAC GF-6B Passenger Car Engine Oil Standard

Requirement	Criterion
Fresh Oil Viscosity Requirements	
SAE J300	Oils shall meet all requirements of SAE J300. Viscosity grades are limited to SAE 0W-16 multigrade oils
Gelation index	ASTM D5133 12 (max) To be evaluated from –5˚C to temperature at which 40,000 cP is attained or –40˚C, or 2 Celsius degrees below appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first
Engine Test Requirements	
Wear and oil thickening	ASTM Sequence IIIH (ASTM D8111)
Kinematic viscosity increase @ 40°C, %	100 (max)
Average weighted piston deposits, merits	4.2 (min)
Hot stuck rings	None
Wear, sludge, and varnish	ASTM Sequence VH (ASTM DXXXX)
Average engine sludge, merits	7.6 (min)
Average rocker cover sludge, merits	7.7 (min)
Average engine varnish, merits	8.6 (min)
Average piston skirt varnish, merits	7.6 (min)
Oil screen sludge, % area	Rate and report
Oil screen debris, % area	Rate and report
Hot-stuck compression rings	None
Cold stuck rings	Rate and report
Oil ring clogging, % area	Rate and report
Valvetrain wear	ASTM Sequence IVB (ASTM DXXXX)
Average intake lifter volume loss (8 position avg), mm^3	2.7 (max)
End of test iron, ppm	400 (max)
Fuel efficiency	ASTM Sequence VIF (ASTM D8226)
SAE 0W-16 viscosity grade	
FEI SUM	4.1% min
FEI 2	1.9% min after 125 hours aging
Low-speed preignition prevention	ASTM Sequence IX (ASTM DXXXX)
Average number of events for four iterations	5 (max)
Number of events per iteration	8 (max)
Chain wear	ASTM Sequence X (ASTM DXXXX)
Percent increase	0.085 (max)

Table Q-6B—ILSAC GF-6B Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Bench Test Requirements	
Catalyst compatibility	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.08 (max)
Phosphorus volatility (Sequence IIIHB, phosphorus retention)	ASTM D7320 81% (min)
Sulfur content	ASTM D4951, D5185, or D2622
SAE 0W and 5W multigrades, % (mass)	0.5 (max)
Wear	ASTM D4951 or D5185
Phosphorus content, % (mass)	0.06 (min)
Volatility	ASTM D5800 (B&D)
Evaporation loss, %	15.0 (max), 1 hour at 250°C
Filterability	ASTM D6794
EOWTT, %	
with 0.6% H_2O	50 (max) flow reduction
with 1.0% H_2O	50 (max) flow reduction
with 2.0% H_2O	50 (max) flow reduction
with 3.0% H_2O	50 (max) flow reduction Note: Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.
EOFT, %	ASTM D6795 50 (max) flow reduction
Fresh oil foaming characteristics	ASTM D892 (Option A and excluding paragraph 11)
Tendency, mL	
Sequence I	10 (max)
Sequence II	50 (max)
Sequence III	10 (max)
Stability, mL, after 1-minute settling	
Sequence I	0 (max)
Sequence II	0 (max)
Sequence III	0 (max)
Fresh oil high temperature foaming characteristics	ASTM D6082 (Option A)
Tendency, mL	100 (max)
Stability, mL, after 1-minute settling	0 (max)

Table Q-6B—ILSAC GF-6B Passenger Car Engine Oil Standard (Continued)

Requirement	Criterion
Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	ROBO (ASTM D7528) a) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. b) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). c) EOT ROBO sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above. or
Aged oil low temperature viscosity Measure aged oil low temperature viscosity on final formulation (pursuant to existing read across described in Annex F)—this includes base oil and additive combination being licensed—for each viscosity grade by either ROBO or IIIHA Measure CCS viscosity of EOT ROBO or IIIHA sample at CCS temperature corresponding to original viscosity grade	ASTM Sequence IIIHA (ASTM D8111) d) If CCS viscosity measured is less than or equal to the maximum CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade. e) If CCS viscosity measured is higher than the maximum viscosity specified for the original viscosity grade in J300, run ASTM D4684 (MRV TP-1) at 5°C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade). f) EOT IIIHA sample must show no yield stress in the D4684 test and its D4684 viscosity must be below the maximum specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, depending on the CCS viscosity grade, as outlined in a) or b) above.
Shear stability KV @ 100°C after 30 passes, cSt	Diesel Injector (ASTM D6278) 5.8 (min)
Homogeneity and miscibility	ASTM D6922 Shall remain homogeneous and, when mixed with ASTM Test Monitoring Center (TMC) reference oils, shall remain miscible.
Engine rusting Average gray value	Ball Rust Test (ASTM D6557) 100 (min)
Emulsion retention 0°C, 24 hours 25°C, 24 hours	ASTM D7563 No water separation No water separation
Elastomer compatibility	ASTM D7216 Annex A2 Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643. Candidate oil testing shall be performed according to ASTM D7216 Annex A2. The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed below:

Elastomer Material (SAE J2643)	Test Procedure	Material Property	Units	Limits
Polyacrylate Rubber (ACM-1)	ASTM D471	Volume	% Δ	-5, 9
	ASTM D2240	Hardness	pts.	-10, 10
	ASTM D412	Tensile Strength	% Δ	-40, 40
Hydrogenated Nitrile Rubber (HNBR-1)	ASTM D471	Volume	% Δ	-5, 10
	ASTM D2240	Hardness	pts.	-10, 5
	ASTM D412	Tensile Strength	% Δ	-20, 15
Silicone Rubber (VMQ-1)	ASTM D471	Volume	% Δ	-5, 40
	ASTM D2240	Hardness	pts.	-30, 10
	ASTM D412	Tensile Strength	% Δ	-50, 5
Fluorocarbon Rubber (FKM-1)	ASTM D471	Volume	% Δ	-2, 3
	ASTM D2240	Hardness	pts.	-6, 6
	ASTM D412	Tensile Strength	% Δ	-65, 10
Ethylene Acrylic Rubber (AEM-1)	ASTM D471	Volume	% Δ	-5, 30
	ASTM D2240	Hardness	pts.	-20, 10
	ASTM D412	Tensile Strength	% Δ	-30, 30

Applicable Documents:

1. SAE Standard, Engine Oil Viscosity Classification—SAE J300, *SAE Handbook*.
2. SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5—SAE J2643, *SAE Handbook*.
3. ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.
5. M. Batko and D. F. Florkowski, “Low Temperature Rheological Properties of Aged Crankcase Oils,” SAE Paper 2000-01-2943.
6. M. Batko and D. F. Florkowski, “Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine,” SAE Paper 01FL-265

Annex R

API Guidelines for Use of Single Technology Matrix

R.1 General

A Single Technology Matrix (STM) approach may be used in addition to the Base Oil Interchangeability (BOI) and SAE Viscosity-Grade Testing (VGRA) Guidelines included in Annexes E and F. The STM approach must follow the guidelines outlined in R.2 and any engine-test-specific amendments listed in R.6.

R.1.1 Introduction

The BOI/VGRA guidelines in API 1509 are developed through industry consensus. Each guideline is generally derived using the 'minimum quality and quantity of data' rule. This rule requires that three technologies from at least two companies agree on the characteristic behavior of the base oil and/or SAE viscosity grade. This process has the benefit of industry consensus and public display of data, but it is not without limitations: reaching consensus on guidelines is often slow, over-testing in some areas occurs, and the type of data that can be viewed is limited.

The STM approach encompasses a technology or family of technologies from a single supplier in lieu of at least three technologies from different suppliers. The purpose of this approach is to offer an alternate, cost-effective, and technically valid process to demonstrate the performance capability of an additive technology. The matrix can be as broad or narrow in its application as are the industry guidelines. Note that while the guidelines developed through the traditional three-technologies approach applies to all technologies tested in the future, the guidelines developed from a Single Technology Matrix approach apply only to the technology or technologies used in that Matrix.

The additive technology supplier will provide the Oil Marketer with appropriate information from the Single Technology Matrix that the Oil Marketer may elect to utilize in applying for an API License.

R.1.2 Definitions

R.1.2.1 A *Single Technology* as designed for use in a Single Technology Matrix is a single additive package (DI) at a constant treat rate, with a single viscosity modifier, and in a single viscosity grade.

R.1.2.2 A *Modified Technology* as designed for use in a Single Technology Matrix is a minor formulation modification to a Single Technology and/or a viscosity grade change to a Single Technology.

R.1.2.3 A *Single Technology Matrix* consists of a group of data meeting the criteria outlined in R.2. The test results in the matrix reflect data from a Single Technology as described in R.1.2.1 and, if necessary, a Modified Technology as described in R.1.2.2

R.1.2.4 A *Multiple Technology Matrix* consists of two or more Single Technology Matrices meeting the criteria outlined in R.2. A Multiple Technology Matrix developed within an API category cannot extend to future API categories unless recommended by the API BOI/VGRA Task Force and approved by the API Lubricants Standards Group.

R.1.2.5 A *Base Stock* is a lubricant component that is produced by a single manufacturer to the same specifications (independent of feed source or manufacturer's location); that meets the same manufacturer's specification; and that is identified by a unique formula, product identification number, or both. Base stocks may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining. Rerefined stock shall be substantially free from materials introduced through manufacturing, contamination or previous use.

R.1.2.6 A *Base Oil* used in a Technology Matrix can consist of a single base stock or a blend of base stocks. The *Base Oil* can consist of the same or multiple slates of base stocks. The *Base Oil* is defined, at minimum, by the following variables:

a. Base Oil Saturates (ASTM D2007)
b. Base Oil Sulfur (API Approved Tests from Annex E, Table E-1)
c. Base Oil Viscosity at 100°C (ASTM D445)
d. Base Oil Viscosity Index (ASTM D2270)
e. Noack Volatility of the fully formulated oil (finished oil) (ASTM D5800)

R.1.2.7 An *Outlier* is a test result in which the Studentized Residual for that observation from the analysis is at the one-sided 97.5th percentile, or beyond, on a Student T distribution.

R.1.2.8 A *Spread Requirement* is a stipulation on the base oil variable results in the Matrix that facilitates a symmetric spread in those results. For the base oil variable of interest, the number of base oils on either side of the mean of all base oils in the matrix must be equal, or within 1 of equal (if the total number of base oils is an odd number) in order to satisfy the spread requirements. Note that there is a default spread requirement for base oil saturates for all engine test types unless the Spread Requirement Waiver for Saturates applies.

R.1.2.9 The *Spread Requirement Waiver for Saturates* allows for the elimination of any spread requirement for saturates, if, and only if, every base oil AND base stock in the matrix is Group II, Group III, and/or Group IV.

R.1.2.10 A *Minor Formulation Modification* is a change made within a Single Technology Matrix to the Single Technology formulation with the intent to improve the performance of the formulation. Such a change creates a Modified Technology within the Single Technology Matrix. Base oil interchange on future base oils may only be granted for the last Modified Technology from the Single Technology Matrix. The guidelines and rules for Minor Formulation Modifications are defined in the American Chemistry Council Product Approval Code of Practice.

R.1.2.11 A *Viscosity Grade Change* is a change made within a Single Technology Matrix to the viscosity grade of the Single Technology in the direction of previously approved API 1509 Viscosity Grade Read Across Guidelines. Such a change creates a Modified Technology within the Single Technology Matrix. Base oil interchange on future base oils may only be granted for the least difficult viscosity grade tested in the Single Technology Matrix as defined by API 1509 Viscosity Grade Read Across Guidelines.

R.2 Scope and Criteria for a Single Technology Matrix

R.2.1 Matrix Data Criteria

The Matrix data must be developed using a Single Technology as described in R.1.2.1, and, if necessary, a Modified Technology or Modified Technologies as described in R.1.2.2. A minimum of X operationally valid tests on X different base oils is required for a suitable matrix (see Table R-1). X is either equal to 5 or equal to the number of base oil variables of interest plus 2 (to ensure that there are enough degrees of freedom to estimate the error term from the matrix), whichever is greater. Note, however, that for every Modified Technology used in the matrix, X must increase by 1. Base oil variables of interest are determined by the API BOI/VGRA Task Force on a per test-type basis. The range of base oil variables of interest plus, if not included in that list, the ranges of base oil VI, base oil sulfur, base oil saturates, base oil viscosity at 100°C and finished oil Noack volatility (note that finished oil Noack volatility is considered a base oil variable for this STM application even though the volatility measurement is on the finished fluid) in that Matrix must cover any base oil interchange. To extend to another base oil beyond this range would require at least one additional test using a base oil that extends the range.

The base oil saturates in the Matrix must also meet a spread requirement (unless the Spread Requirement Waiver for Saturates applies). The number of base oils on either side of the mean saturates of all the base oils in the matrix must be equal (or within 1 of equal if the total number of base oils is an odd number).

To improve data efficiencies, multiple Single Technology Matrices may be combined and analyzed. This combination is known as the Multiple Technology Matrix. Whereas X tests on X different base oils are required from the first Single Technology Matrix, only X-1 operationally valid tests on X-1 different base oils are required from an additional Single Technology Matrix if that second Matrix is combined and analyzed with the first. If a third Single Technology Matrix is combined with the first two, that third Matrix would need a minimum of X-2 operationally valid tests on X-2 different base oils. Any additional Single Technology Matrices combined and analyzed with the others would require a minimum of X-2 operationally valid tests on X-2 different base oils. Note that in this combined Multiple Technology Matrix, the extremes of the base oils in terms of saturates, sulfur, VI, base oil viscosity, and other pertinent parameters must be represented, and the spread requirement for saturates must be satisfied for each new technology.

Note: A Multiple Technology Matrix developed within an API category cannot extend to future API categories unless recommended by the API BOI/VGRA Task Force and approved by the API Lubricants Standards Group.

Table R-1—Minimum Number of Base Oils for Matrix

Technology in the Matrix	Minimum Number of Base Oils per Technology
First Technology	The greater of 5 or (defined base oil variables + 2): Add 1 base oil for each Modified Technology within the first technology
Second Technology	The greater of 4 or (defined base oil variables + 1): Add 1 base oil for each Modified Technology within the second technology
Third Technology and Subsequent Technologies	The greater of 3 or (defined base oil variables): Add 1 base oil for each Modified Technology within each technology

R.2.2 Interchange Criteria Based on Statistical Confidence Limits

Based on the Matrix and subsequent analysis, the predicted engine test result for the new base oil (interchange base oil) must meet the performance specification of interest. In addition, the 95% confidence interval for the predicted mean performance (based on the Student T distribution) must be within the performance specification of interest. If, however, this confidence interval extends beyond the pass limit into the fail region of the specification, then, and only then, the width of the 95% confidence interval (based on the Student T distribution) for the predicted mean performance cannot be greater than the width of the 95% confidence interval (based on the Normal Frequency Distribution and the current standard deviation of the test used in the calculation of severity adjustments as defined in ASTM Test Monitoring Center Technical Memorandum 94-200, Annex C of the LTMS Manual) for the mean based on a single test result at the predicted performance level. Although the confidence intervals must be calculated in the appropriate transformed units, the comparison must be made in original units.

Given that the interchange criteria from the Matrix and statistical analysis are met, base oil interchange may be used for the technology from the Single Technology Matrix and/or the technologies from the Multiple Technology Matrix. Base oil interchange may also be used for all minor formulation modifications of these technologies with the proper Level 1 and/or Level 2 Support as defined in Annex H of the *American Chemistry Council Product Approval Code of Practice* (ACC Code).

The Matrix data and analysis must be shown to the Oil Marketer. A test result for a test parameter may be declared as an outlier and dropped from the analysis in accordance with R.2.4. However, the minimum number of base oils per technology criteria as outlined in R.2.1 as well as all other analysis and confidence limit requirements must be met. The observation must be an outlier for it to be dropped from the analysis. While observations may be dropped according to the Multiple Test Evaluation Procedure (MTEP) to determine pass/fail, those observations may not be dropped from the Single Technology Matrix analysis unless declared an outlier according to R.2.4.

Non-conformance through an audit will be subject to enforcement action as described in Annex M and Section 8.

R.2.3 Calculation of Width of 95% Confidence Interval

R.2.3.1 Confidence Interval Width for a Mean Based on a Single Test Result

$$2 \times Z_{0.05} \times \sigma$$

Where:

$Z_{0.05}$ = 1.96

σ = current standard deviation of the test used in the calculation of severity adjustments as defined in ASTM Test Monitoring Center Technical Memorandum 94-200, Annex C, of the LTMS Manual.

This is the shortcut method for calculating the width of the confidence interval. If a transformation is required, the shortcut method cannot be used. The actual confidence interval must be calculated for the predicted result for the oil on the transformed scale. This is done by adding and subtracting $Z_{0.05} \times \sigma$ from the predicted test result, transforming the confidence limits back, and then subtracting the limits on the original scale.

R.2.3.2 Predicted Test Result Confidence Interval Width

$$2 \times t_{0.05,df} \times S \times \sqrt{h_i}$$

Where:

$t_{0.05,df}$ = Student T distribution at the 95% Confidence Level with degrees of freedom equal to the degrees of freedom used in the estimate of the Root Mean Squared Error (RMSE)

S = Root Mean Squared Error from the analysis

h_i = $x_i (X'X)^{-1} x_i'$

X = the factor matrix

x_i = a particular factor setting

This is the shortcut method for calculating the width of the confidence interval. If a transformation is required, the shortcut method cannot be used. The actual confidence interval must be calculated for the predicted result for the oil on the transformed scale. This is done by adding and subtracting $t_{0.05,df} \times S \times \sqrt{h_i}$ from the transformed predicted result, transforming the confidence limits back, and then subtracting the limits on the original scale.

R.2.4 Calculation of the Studentized Residual and Outlier Test

$$e^*_i = e_i / (S(i) \times (\sqrt{1-h_i}))$$

Where:

e^*_i = the Studentized Residual, which is distributed closely to the Student T distribution. In this application, the ith observation for a test parameter may be declared as an outlier and removed from the analysis if e^*_i is greater than the one sided $t_{0.025,df}$ with degrees of freedom equal to the degrees of freedom used in the estimate of the Root Mean Squared Error

e_i = the residual from the analysis, the actual test result for the ith observation for a parameter minus the predicted test result for the ith observation for a parameter

S(i) = Root Mean Squared Error from the analysis with the ith observation removed from the analysis

h_i = $x_i (X'X)^{-1} x_i'$

X = the factor matrix

x_i = a particular factor setting

R.3 Summary of Requirements for the Single Technology Matrix

The requirements for the Single Technology Matrix are summarized below:

a. A new test is developed and introduced as a part of a new specification.
b. The API BOI/VGRA Task Force reviews the new test, defines the critical base oil variables, and recommends use of the Single Technology Matrix.
c. The API Lubricants Standards Group approves the critical base oil variables and use of the Single Technology Matrix for the new test.
d. The Matrix Data Criteria must be met as defined in R.2.1.
e. All tests in the development of the Single Technology Matrix dataset and analysis must be registered according to the ACC Code.
f. The single technology must pass within a single test result or by using the appropriate MTEP for each base oil in the Single Technology Matrix for all relevant test parameters. If not, a Minor Formulation Modification or a Viscosity Grade Change may be made to the Single Technology to create a Modified Technology within the Single Technology Matrix. The Modified Technology must then pass all remaining base oils, not passed using the Single Technology, within a single test result or by using the appropriate MTEP for all relevant test parameters. The minimum number of base oils in the Single Technology Matrix MUST increase by one (1)

for every Modified Technology used to demonstrate an acceptable Single Technology Matrix for future Base Oil Interchange.

g. Test results or observations dropped for evaluation in an MTEP procedure may not be dropped from the Single Technology Matrix analysis unless declared an outlier according to R.2.4.
h. The width of the 95% confidence interval (based on the Student T distribution) for the predicted mean performance based on the Single Technology Matrix model cannot be greater than the width of the 95% confidence interval (based on the Normal Frequency Distribution and the current standard deviation of the test used in the calculation of severity adjustments as defined in ASTM Test Monitoring Center Technical Memorandum 94-200, Annex C, of the LTMS Manual) for the mean based on a single test result at the predicted performance level UNLESS the 95% confidence interval for the predicted mean performance (based on the Student T distribution) is within the performance specification of interest (see R.2.2).
i. Single Technology Matrix results must be included in ACC candidate data packages.
j. Notification of use of Single Technology Matrix data for API licensure will be present on an Oil Marketer's API License Form and must be checked if used. An example is provided in R.5.
k. API will survey additive companies on a regular basis for Single Technology Matrix data.

R.4 Examples for Single Technology Matrix Approach

Note: The examples below only use some of the base oil variables required for the Single Technology Matrix. All of the required variables must be used when a Single Technology Matrix is being assembled.

R.4.1 Example 1

Do we have base oil interchange for Technology 1 shown in Table R-2 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-2—Example 1 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	8.1
1	2	70	8.6
1	3	80	8.4
1	4	90	8.9
1	5	100	9.2

There are two base oils with saturates above and two base oils with saturates below the mean saturates of all base oils. Therefore, the spread requirement for saturates is satisfied.

The Model based on saturates has an R^2 of 85% with a RMSE of 0.1889 with 3 degrees of freedom. The width of the 95% Confidence Interval for Technology 1 in the new base oil is 0.5702.

The industry standard deviation for the test is 0.25; therefore, a reasonable and fair estimate of the width of the 95% Confidence Interval for the mean based on a single test result is 0.98.

Since the width of the Confidence Interval from the Model is less than the width of the Confidence Interval for the mean based on a single test result, we have base oil interchange.

R.4.2 Example 2

Do we have base oil interchange for Technology 1 shown in Table R-3 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-3—Example 2 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	8.6
1	2	70	8.4
1	3	80	9.2
1	4	90	8.1
1	5	100	8.9

There are two base oils with saturates above and two base oils with saturates below the mean saturates of all base oils. Therefore, the spread requirement for saturates is satisfied.

The Model is just the mean of the data with a RMSE of 0.4278 with 4 degrees of freedom. The width of the 95% Confidence Interval for Technology 1 in the new base oil is 0.5311.

The industry standard deviation for the test is 0.25; therefore, a reasonable and fair estimate of the width of the 95% Confidence Interval for the mean based on a single test result is 0.98.

Since the width of the Confidence Interval from the Model is less than the width of the Confidence Interval for the mean based on a single test result, we have base oil interchange.

R.4.3 Examples 3A and 3B

R.4.3.1 Example 3A

Do we have base oil interchange for Technology 1 shown in Table R-4A in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-4A—Example 3A Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	8.6
1	2	91	8.4
1	3	93	9.2
1	4	96	8.1
1	5	100	8.9

No. There are four base oils above the mean saturates of all of the base oils in the matrix (mean saturates = 88) and only one base oil below the mean. Therefore, the spread requirement is not satisfied, and we cannot analyze this Matrix for base oil interchange.

R.4.3.2 Example 3B

Do we have base oil interchange for Technology 1 shown in Table R-4B in a new base oil that is 95% saturates in a test where the pass limit is a minimum of 8.0?

Table R-4B—Example 3B Variables

Technology	Base Oil	Saturates	Test Result
1	1	90	8.6
1	2	97	8.4
1	3	98	9.2
1	4	99	8.1
1	5	100	8.9

Although there are four base oils above the mean saturates of all of the base oils in the matrix (mean saturates = 96.8) and only one base oil below the mean, the spread requirement for saturates is waived because all base oils (and for the purpose of this example, all base stocks) are Group II. The calculations on the test results are the same as R.4.2, and we would have base oil interchange.

R.4.4 Example 4

Do we have base oil interchange for Technology 1 shown in Table R-5 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-5—Example 4 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	9.8
1	2	70	7.1
1	2	70	8.9
1	3	80	8.9
1	4	90	5.0
1	4	90	7.9
1	4	90	8.1
1	5	100	9.4

There are two base oils with saturates above and two base oils with saturates below the mean saturates of all base oils. Therefore, the spread requirement for saturates is satisfied.

The Model is just the mean of the data with a RMSE of 1.535 with 7 degrees of freedom. The width of the 95% Confidence Interval for Technology 1 in the New Base Oil is 2.5670 (the 95% Confidence Interval is 6.9 to 9.4).

The Industry standard deviation for the test is 0.25; therefore, a reasonable and fair estimate of the width of the 95% Confidence Interval for the mean based on a single test result is 0.98.

Since the width of the Confidence Interval from the Model is more than the width of the Confidence Interval for the mean based on a single test result AND the lower end of the Confidence Interval from the model (6.9) extends below the pass limit of 8.0, we DO NOT have Base Oil Interchange.

However, we notice that the test result of 5.0 is unusually low. The Studentized Residual for this observation is 3.6, which is greater than the one sided $t_{0.025,7}$ of 2.4. The observation may then be removed from the analysis since the number of base oils remains at five. If the observation were to be removed as an outlier, then the lower end of the Confidence Interval for Technology 1 in the New Base Oil would be greater than the pass limit (the width would also be less than 0.98), and we would have Base Oil Interchange.

R.4.5 Example 5

Do we have base oil interchange for Technology 1 shown in Table R-6 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-6—Example 5 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	9.8
1	2	70	7.1
1	2	70	8.0
1	3	80	8.9
1	4	90	5.0
1	4	90	7.9
1	4	90	8.1
1	5	100	9.4

No. We do not have a pass in Base Oil Number 2 for this Technology. Note that we do have a pass in Base Oil Number 4 using MTAC.

R.4.6 Example 6

Do we have base oil interchange for both Technology 1 and Technology 2 shown in Table R-7 in a new base oil that falls between the extremes of the base oil characteristics in a test where the pass limit is a minimum of 8.0?

Table R-7—Example 6 Variables

Technology	Base Oil	Base Oil Characteristics	Test Result
1	1	Extreme High	8.1
1	2	Medium	8.6
1	3	Low	8.4
1	4	High	8.9
1	5	Extreme Low	9.2
2	1	Extreme High	8.9
2	6	Medium	9.2
2	7	High	9.6
2	5	Extreme Low	8.8

The Model based on Technology 1 has an R^2 of 32% with a RMSE of 0.3999 with 7 degrees of freedom. The width of the 95% Confidence Interval for Technology 1 in the new base oil is 0.846. The width of the 95% Confidence Interval for Technology 2 in the new base oil is 0.946.

The industry standard deviation for the test is 0.25; therefore, a reasonable and fair estimate of the width of the 95% Confidence Interval for the mean based on a single test result is 0.98.

Since the width of the Confidence Interval from the Model is less than the width of the Confidence Interval for the mean based on a single test result for both Technologies, we have base oil interchange for both Technologies.

R.4.7 Example 7

Do we have base oil interchange for Technology 1 shown in Table R-8 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-8—Example 7 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	8.5
1	2	70	7.1
1A	2	70	8.6
1A	3	80	8.9
1A	4	90	5.0
1A	4	90	8.9
1B	4	90	8.8
1B	5	100	9.0

No. Since we have made two minor formulation modifications, we would need test results in two additional base oils. Also note that Technology 1 is not eligible for base oil interchange. Only Technology 1B is eligible.

R.4.8 Example 8

Do we have base oil interchange for Technology 1B shown in Table R-9 in a new base oil that is 75% saturates in a test where the pass limit is a minimum of 8.0?

Table R-9—Example 8 Variables

Technology	Base Oil	Saturates	Test Result
1	1	60	8.5
1	2	70	7.1
1A	2	70	8.6
1A	3	80	8.9
1A	4	90	5.0
1A	4	90	8.9
1B	4	90	8.8
1B	5	100	9.0
1B	6	75	8.7
1B	7	85	8.7

Yes, assuming that Technology 1A and Technology 1B are minor formulation modifications as defined in the American Chemistry Council Product Approval Code of Practice. We have added two base oils to compensate for the two Modified Technologies, the spread requirement is satisfied, and the width of the Confidence Interval from the Model is less than the width of the Confidence Interval for the mean based on a single test result (assuming an industry standard deviation of 0.25). Note, however, that we only have interchange when using Technology 1B. We do not have interchange when using Technology 1 or Technology 1A.

R.5 Notification of Single Technology Matrix Use to API

Oil Marketers must notify API on Parts B and Q of the EOLCS Application for Licensure whenever Single Technology Matrix data is used to qualify an oil formulation for API licensing. The EOLCS Online Application includes check boxes that specifically ask if STM has been used. It is below the BOI and VGRA check boxes. The EOLCS Online Application also asks the Oil Marketer to identify which test(s) use the STM support data. An example of the information requested is shown in Figure R-1.

Note: The Oil Marketer must have the STM support data on-file.

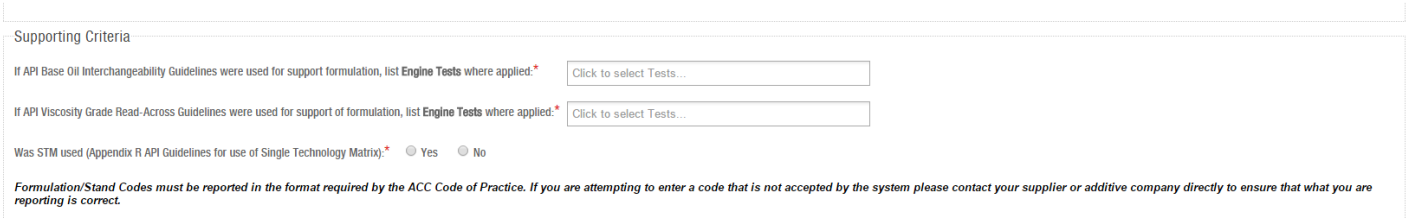

Figure R-1—Example of STM Check-Off in EOLCS Online Application

R.6 Specific Engine Tests Approved for STM

R.6.1 Sequence IIIF

The critical base oil variables are:

- Base Oil Saturates (ASTM D2007)
- Base Oil Sulfur (except when base oil sulfur level is less than or equal to 0.03%) (API approved tests from Annex E, Table E-1)
- Base Oil Viscosity at 100°C (ASTM D445)
- Base Oil Viscosity Index (ASTM D2270)
- Noack Volatility of the fully formulated oil (finished oil) (ASTM D5800)

The Single Technology Matrix must consist of at least 7 different base oils. The relevant test parameters are:

- Percent Viscosity Increase at 80 Hours
- Weighted Piston Deposits
- Average Piston Varnish
- Average Camshaft plus Lifter Wear
- Stuck Rings

The Single Technology Matrix must consist of a minimum number of base oils consistent with Table R-1. Each technology in the STM must pass each relevant test parameter (within 1 test or by MTAC) in each base oil.

Confidence Intervals are applicable to each relevant test parameter except Average Camshaft plus Lifter Wear and Stuck Rings.

Passenger car motor oil (PCMO) technologies cannot be used with heavy duty diesel engine oil (HDEO) technologies in the same Multiple Technology Matrix. If a Multiple Technology Matrix is used, it must consist of either all PCMO technology or all HDEO technology.

In addition to any default spread requirements, there is a spread requirement for base oil viscosity index.

R.6.2 Detailed Example Using the Sequence IIIF

Do we have base oil interchange for Technology 1 shown in Table R-10 in a new base oil that is within the ranges for base oil saturates, sulfur, viscosity, viscosity index and blend volatility in the IIIF?

Table R-10—Sequence IIIF Parameters for Example Using STM

Base Oil	Base Oil Saturates D 2007	Base Oil Sulfur D 4294	Finished Oil Noack Volatility D 5800	Base Oil Viscosity @ 100°C D 445	Base Oil Viscosity Index D 2270	IIIF Percent Viscosity Increase	IIIF Weighted Piston Deposits	IIIF Average Piston Varnish	IIIF Average Cam plus Lifter Wear	IIIF Stuck Rings
1	75.4	0.2049	16.9	5.61	105	311.2	4.92	9.1	10.8	0
1	75.4	0.2049	16.9	5.61	105	190	4.44	9.4	7.0	0
2	68.3	0.3055	18.2	4.46	100	270.4	4.17	9.1	7.9	0
3	70.7	0.3132	15.8	4.39	102	108.3	3.76	8.9	6.8	0
3	70.7	0.3132	15.8	4.39	102	268	4.44	9.1	8.2	0
4	66.7	0.2171	16.6	4.86	104	111.4	5.20	9.2	7.7	0
5	73.9	0.3423	13.9	5.10	103	162.1	4.32	9.2	5.6	0
6	84.1	0.0740	14.7	5.47	102	67	4.2	9.4	5.1	0
7	61.2	0.3641	16.0	4.31	96	311.1	3.95	9.5	8.7	0
7	61.2	0.3641	16.0	4.31	96	212	3.97	9.5	5.7	0
New	72	0.25	16.2	5.00	102					

Step 1: Do we have enough base oils in the Matrix?

Yes. We have 7 base oils in the Matrix. The minimum number of tests is the number of critical base oil variables (saturates, sulfur, viscosity at 100°C, and viscosity index) and the Noack volatility of the fully formulated oil plus two.

Step 2: Do we satisfy the spread requirement for both saturates and base oil viscosity index?

Yes. There are four base oils with saturates below the mean saturates of all base oils of 71.5 and three base oils above this mean. There are four base oils with a base oil viscosity index below the mean base oil viscosity index of all base oils of 102.1 and three base oils above this mean.

Step 3: Do we pass Technology 1 in every base oil in the Matrix?

Yes. Some pass with one test and some pass by MTAC.

Step 4: Do we predict a pass for Technology 1 in the new base oil based on the analysis of the Matrix?

Yes. The prediction for the new base oil is based on a very simple model (see Table R-11), the average over all other base oils since no base oil effects were evident with this technology over the range tested.

Table R-11—Step 4: Model Predicted

Base Oil	Base Oil Saturates D 2007	Base Oil Sulfur D 4294	Finished Oil Noack Volatility D 5800	Base Oil Viscosity @ 100°C D 445	Base Oil Viscosity Index D 2270	Model Predicted				
						IIIF Percent Viscosity Increase	IIIF Weighted Piston Deposits	IIIF Average Piston Varnish	IIIF Average Cam plus Lifter Wear	IIIF Stuck Rings
New	72	0.25	16.2	5.00	102	201	4.3	9.2	7.4	0

Step 5: Are there any outliers?

Possible outliers would include test results in which the Studentized residuals exceed the Student T distribution at the one-sided 0.025 percentile with degrees of freedom used in the calculation of the Root Mean Squared Error from the model, which is 9.

$$t_{0.05,9} = 2.262$$

According to the calculations in R.2.4, there are two possible outliers (see Table R-12). These outliers should be investigated as to their possible cause. Given that an investigation has not yet taken place, the outliers are not removed in this example. After future investigation, the test sponsor may remove these identified outliers on a parameter-by-parameter basis. However, please note that the outlier of 2.65 identified for Weighted Piston Deposits CANNOT be removed unless another test is run on this Technology to bring the number of base oils in the Matrix for Weighted Piston Deposits back to seven.

Table R-12—Step 5: Studentized Residuals

Test Number	IIIF Percent Viscosity Increase	IIIF Weighted Piston Deposits	IIIF Average Piston Varnish	IIIF Average Cam plus Lifter Wear	IIIF Stuck Rings
1	1.38	1.47	-0.71	*2.86*	0
2	-0.13	0.23	0.82	-0.20	0
3	0.81	-0.38	-0.71	0.32	0
4	-1.13	-1.45	-2.09	-0.32	0
5	0.78	0.23	-0.71	0.50	0
6	-1.08	*2.65*	-0.20	0.20	0
7	-0.45	-0.04	-0.20	-1.09	0
8	-1.79	-0.31	0.82	-1.48	0
9	1.38	-0.91	1.44	0.82	0
10	0.12	-0.86	1.44	-1.02	0

Step 6: Is the lower end of the 95% Confidence Interval (based on the Student T distribution) for the predicted mean performance based on the Single Technology Matrix model within the pass region for all relevant test parameters? If not, is the width of the 95% Confidence Interval (based on the Student T distribution) for the predicted mean performance based on the Single Technology Matrix model less than or equal to the width of the 95% Confidence Interval (based on the Normal Frequency Distribution and the current standard deviation of the test used in the calculation of severity adjustments as defined in ASTM Test Monitoring Center Technical Memorandum 94-200, Annex C, of the LTMS Manual) for the mean based on a single test result at the predicted performance level for all relevant test parameters?

Yes. Calculations are presented below for Percent Viscosity Increase and summarized for all other test parameters.

Confidence Interval for the Mean Based on a Single Test Result:

$$\text{Transform(Result)} + (Z_{0.05} \times \sigma) \quad \text{to} \quad \text{Transform(Result)} - (Z_{0.05} \times \sigma)$$

Where:

Result = predicted test result for the new Base Oil based on the STM analysis
Transform = Industry transformation for this test; the inverse square root

σ = current standard deviation of the test used in the calculation of severity adjustments as defined in ASTM Test Monitoring Center Technical Memorandum 94-200, Annex C, of the LTMS Manual.

$$1/(\text{Result})^{1/2} + (1.96 \times 0.0129546) \text{ to } 1/(\text{Result})^{1/2} - (1.96 \times 0.0129546)$$

$$1/(201)^{1/2} + (1.96 \times 0.0129546) \text{ to } 1/(201)^{1/2} - (1.96 \times 0.0129546)$$

0.0959 to 0.0451 in transformed units

95% Confidence Interval for the true mean of Percent Viscosity Increase based on a single test result using the industry-published standard deviation equals 109 to 491

The width of the Confidence Interval in original units equals 491 – 109 = 382

Predicted Test Result Confidence Interval Width:

$$\text{Transform(Result)} + (t_{0.05,df} \times S \times \sqrt{h_i}) \text{ to } \text{Transform(Result)} - (t_{0.05,df} \times S \times \sqrt{h_i})$$

Where:

Result = predicted test result for the new base oil based on the STM analysis
Transform = transformation used in this STM analysis: none
S = Root Mean Squared Error (RMSE) from this STM analysis
df = degrees of freedom used in calculating the RMSE

(Result) – (2.262 x 88.13112 x 0.3162) to (Result) + (2.262 x 88.13112 x 0.3162)

(201) – (63.0353) to (201) + (63.0353)

95% Confidence Interval for the true mean of Percent Viscosity Increase based on the data and analysis of the STM equals 138 to 264.

The width of the Confidence Interval in original units equals 264 – 138 = 126. A summary of the confidence interval widths is shown in Table R-13.

Table R-13—Summary of Confidence Interval Widths

IIIF Parameter	Confidence Interval Width for a Mean Based on a Single Test Result	Predicted Test Result Confidence Interval Width	Predicted Test Result Confidence Interval Width Smaller?
Percent Viscosity Increase	382	126	YES
Weighted Piston Deposits	2.58	0.63	YES
Average Piston Varnish	0.86	0.29	YES

Step 7: Do we have base oil interchange for Technology 1 in a new base oil that is within the ranges for base oil saturates, sulfur, viscosity, viscosity index, and blend volatility in the Sequence IIIF?

Yes

R.6.3 Sequence IIIF-HD

The critical base oil variables are:

- Base Oil Saturates (ASTM D2007)
- Base Oil Sulfur (except when base oil sulfur level is less than or equal to 0.03%) (API approved tests from Annex E, Table E-1)

- Base Oil Viscosity at 100°C (ASTM D445)
- Base Oil Viscosity Index (ASTM D2270)
- Noack Volatility of the fully formulated oil (finished oil) (ASTM D5800)

The Single Technology Matrix must consist of at least 7 different base oils. The relevant test parameter is:

- Percent Viscosity Increase at 60 Hours

The Single Technology Matrix must consist of a minimum number of base oils consistent with Table R-1. Each technology in the STM must pass each relevant test parameter (within 1 test or by MTAC) in each base oil.

Confidence Intervals are applicable to each relevant test parameter except Hot Stuck Piston Rings.

Passenger car motor oil (PCMO) technologies cannot be used with heavy duty diesel engine oil (HDEO) technologies in the same Multiple Technology Matrix. If a Multiple Technology Matrix is used, it must consist of either all PCMO technology or all HDEO technology.

In addition to any default spread requirements, there is a spread requirement for base oil viscosity index.

R.6.4 Sequence IIIG

The critical base oil variables are:

- Base Oil Saturates (ASTM D2007)
- Base Oil Sulfur (except when base oil sulfur level is less than or equal to 0.03%) (API approved tests from Annex E, Table E-1)
- Base Oil Viscosity at 100°C (ASTM D445)
- Base Oil Viscosity Index (ASTM D2270)
- Noack Volatility of the fully formulated oil (finished oil) (ASTM D5800)

The Single Technology Matrix must consist of at least 7 different base oils. The relevant test parameters are:

- Percent Viscosity Increase at 100 Hours
- Weighted Piston Deposits
- Average Cam plus Lifter Wear
- Hot Stuck Piston Rings

The Single Technology Matrix must consist of a minimum number of base oils consistent with Table R-1. Each technology in the STM must pass each relevant test parameter (within 1 test or by MTAC) in each base oil.

Confidence Intervals are applicable to each relevant test parameter except Hot Stuck Piston Rings.

Passenger car motor oil (PCMO) technologies cannot be used with heavy duty diesel engine oil (HDEO) technologies in the same Multiple Technology Matrix. If a Multiple Technology Matrix is used, it must consist of either all PCMO technology or all HDEO technology.

In addition to any default spread requirements, there is a spread requirement for base oil viscosity index.

R.6.5 Sequence IIIGA

The critical base oil variables are:

- Base Oil Saturates (ASTM D2007)
- Base Oil Sulfur (except when base oil sulfur level is less than or equal to 0.03%) (API approved tests from Annex E, Table E-1)
- Base Oil Viscosity at 100°C (ASTM D445)
- Base Oil Viscosity Index (ASTM D2270)
- Noack Volatility of the fully formulated oil (finished oil) (ASTM D5800)

The Single Technology Matrix must consist of at least 7 different base oils. The relevant test parameter is:

- MRV TP-1

The Single Technology Matrix must consist of a minimum number of base oils consistent with Table R-1. Each technology in the STM must pass the relevant test parameter (MTAC is not applicable) in each base oil.

Confidence Intervals are not applicable to MRV TP-1 due to the nature of test result distribution and extraordinary size of the test variability.

Passenger Car Motor Oil (PCMO) technologies cannot be used with Heavy Duty Engine Oil (HDEO) technologies in the same Multiple Technology Matrix. If a Multiple Technology Matrix is used it must consist of either all PCMO technology or all HDEO technology.

In addition to any default spread requirements, there is a spread requirement for base oil viscosity index.

An additional requirement for use of the Sequence IIIGA matrix is that the fresh oil MRV of the candidate oil, blended to the same viscosity grade, is equal to or less than the fresh oil MRV of at least one of the passing oils in the matrix, within the precision of the test. ASTM D4684 MRV testing is to be carried out at the appropriate temperature as defined in SAE J300.

Annex S

Performance Requirements for C Category Supplements

S.1 Scope

This annex describes the supplemental bench and engine test requirements adopted by the API Lubricants Standards Group for an existing C Category. Oils that meet the requirements for a supplement as defined in this annex and are properly licensed by API may display the supplement's classification in the lower portion of the API Service Symbol in conjunction with the associated C Category in the upper portion.

S.2 Bench and Engine Test Requirements for CI-4 PLUS and CJ-4

Oils that meet the engine and bench requirements for CI-4 PLUS as defined below and are properly licensed by API may display CI-4 PLUS in the lower portion of the API Service Symbol in conjunction with API Service CI-4 and/or CJ-4 in the upper portion. The requirements in this annex include initial base oil interchange and viscosity grade read-across guidelines for the Mack T-11 test. Marketers must also refer to API 1509 for additional guidelines for licensing CI-4 PLUS.

S.2.1 90-Pass Shear Stability Bench Test[a]

The final formulation must meet the following shear stability requirement: The 100°C kinematic viscosity of the oil must stay within its SAE grade after 90 passes in the injector shear bench test.[b]

S.2.2 Mack T-11 Engine Test[a]

All candidate tests must be conducted in an ASTM-calibrated stand. The limits for the Mack T-11 are noted below:

TGA % Soot @ 12.0 cSt increase @ 100°C Linear Interpolation–from 2 data points [New viscosity–after 90 passes (method as per S.2.1)]	6.00 min[c,d]

S.2.2.1 Base Oil Interchange

This section summarizes the methods for comparing the base oil saturates of the formulation being licensed to that in the test oil. The saturate level of the test oil refers to a value for the base oil blend as determined by ASTM D2007. Additive adjustments from the test oil to the final formulation are limited to the Minor Formulation Guidelines contained in the current edition of the ACC Code of Practice.

The methods in Tables S-1 and S-2 and Figure S-1 for determining Base Oil Interchange apply to all Mack T-11 engine tests associated with API CJ-4 and to Mack T-11 engine tests associated with API CI-4 with CI-4 PLUS that were started after April 28, 2006. Base oil interchange for Mack T-11 engine tests associated with API CI-4 and CI-4 PLUS started on or before April 28, 2006, should be determined according to Table S-3.

For the Mack T-11 test, base oil interchange is allowed per Table S-1

Table S-1—Base Oil Interchange for the Mack T-11 in Conjunction with CJ-4 and CI-4 with CI-4 PLUS

Tested Oil	Candidate Oil
X ≤ 70.0	80.0 minimum
70.0 < X < 95.0	(0.6*X + 38) minimum
X ≥ 95.0	95.0 minimum

In addition to using Table S-1, the limits can be defined by graphical means (see Figure S-1) or the use of tabulated limits (see Table S-2).

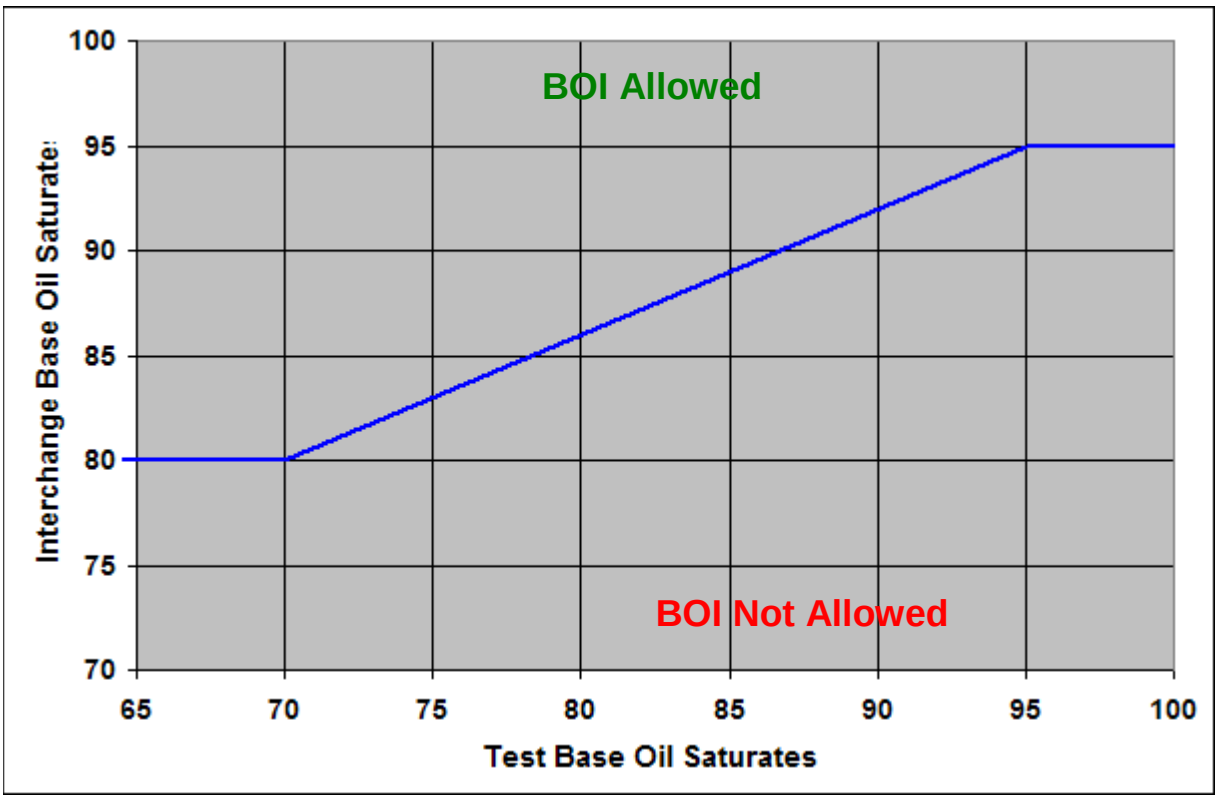

Figure S-1—Plot of Saturates for the Test and Interchange Base Oils

Table S-2—Base Oil Saturates Requirements for BOI

Base Oil Originally Tested for Licensing	Minimum Saturates for Interchange Base Oil
≤70.0	80.0
71.0	80.6
72.0	81.2
73.0	81.8
74.0	82.4
75.0	83.0
76.0	83.6
77.0	84.2
78.0	84.8
79.0	85.4
80.0	86.0
81.0	86.6
82.0	87.2
83.0	87.8
84.0	88.4
85.0	89.0
86.0	89.6
87.0	90.2
88.0	90.8
89.0	91.4
90.0	92.0
91.0	92.6
92.0	93.2
93.0	93.8
94.0	94.4
≥95.0	95.0

Table S-3—Base Oil Interchange for the Mack T-11 in Conjunction with CI-4 with CI-4 PLUS

% Saturates for Final Formulation	Max % Saturates for Test Oil
X < 80.0	No Read across
80.0 ≤ X < 85.0	X-10
85.0 ≤ X < 90.0	X-5
90.0 ≤ X < 95.0	X
X ≥ 95.0	100

S.2.2.2 Viscosity Grade Read Across

Table S-4 contains the VGRA read-across matrix for the Mack T-11 test. When applying the viscosity grade reads allowed by this matrix, two additional conditions must also be met: (1) Base oil saturates in the test and final formulations must comply with the guidelines in S.2.2.1, and (2) in cases where a dispersant viscosity modifier (DVM) is used, the DVM level in the final formulation must be equal to or greater than the level in the test oil.

Table S-4—Viscosity Grade Read across for the Mack T-11

	Read-Across Grades					
Vis Grade Tested	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50
10W-30	NA	X	—	—	—	—
10W-40	X	NA	—	—	—	—
15W-40	X	X	NA	X	—	—
15W-50	X	X	X	NA	—	—
20W-40	X	X	X	X	NA	X
20W-50	X	X	X	X	X	NA

Note: X = Read across allowed; — = Read across not allowed.

[a]90-Pass Shear Stability Test (ASTM D7109); Mack T-11 Test (ASTM D7156).
[b]As defined in the most recent edition of SAE J300.
[c]If technical judgment is used to support Mack T-11 performance, please refer to Annex D, paragraph D.5.2, to determine the appropriate licensing procedure.
[d]For situations where multiple tests are run on the same formulation, the following tiered limits can be applied:

Number of Tests	1	2	3 or More
Minimum %TGA Soot @12.0 cSt increase @100°C	6.00	5.89	5.85

Annex T

Requirements for API Service Categories CK-4 and FA-4 by Viscosity Grade

Table T-1—Requirements for API Service Categories CK-4 and FA-4

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

CK-4 and FA-4 Bench Tests			
		Primary Performance Criteria	
		CK-4	FA-4
ASTM Bench Test	Measured Parameter	SAE J300 viscosity xW-30, xW-40	SAE J300 viscosity xW-30
D4683 (High temperature/high shear) or D4171 or D5481	Viscosity at 150°C, mPa-s		
	xW-30 grades, min	3.5	2.9
	xW-30 grades, max	N/A	3.2
	xW-40 grades	Meet SAE J300	N/A
D6594 (135°C HTCBT)	Copper, mg/kg increase, max	20	20
	Lead, mg/kg increase, max	120	120
	Copper strip rating, max	3	3
D7109	Kinematic viscosity after 90 pass shearing, mm^2/s at 100°C, min		
	xW-30	9.3	9.3
	0W-40	12.5	N/A
	Other xW-40	12.8	N/A
	HTHS viscosity (see above methods) at 150°C, min xW-30 grades	3.4	2.8
D5800 (NOACK)	Evaporative loss at 250°C, %, max	13	13
D892	Foaming/settling, mL, max		
	Sequence I	10/0	10/0
	Sequence II	20/0	20/0
	Sequence III	10/0	10/0
D6896 (Sooted oil MRV TP-1) (D7156 engine test requirement)	Viscosity, 180 h used oil sample from T-11/T-11a test, tested at -20°C, mPa-s, max	25000	25000
	Yield stress of 180 h used oil sample above, Pa, max	<35	<35

CK-4 and FA-4 Chemical Limits			
		Primary Performance Criteria	
		CK-4	FA-4
ASTM Bench Test	Measured Parameter	SAE J300 viscosity xW-30, xW-40	SAE J300 viscosity xW-30
D874	Mass fraction sulfated ash, %, max	1.0	1.0
D4951 or D5185	Mass fraction phosphorus, %, max	0.12	0.12
D4951 or D5185	Mass fraction sulfur, %, max	0.4	0.4

CK-4 and FA-4 Unadjusted Specification Limits for Elastomer Compatibility			
ASTM Bench Test	Elastomer	CK-4	FA-4
D7216 (Seal compatibility)	Nitrile (NBR)		
	Volume change, %	(+5, -3)	(+5, -3)
	Hardness change, points	(+7, -5)	(+7, -5)
	Tensile strength change, %	(+10, -TMC 1006)	(+10, -TMC 1006)
	Elongation at break change, %	(+10, -TMC 1006)	(+10, -TMC 1006)
	Silicone (VMQ)		
	Volume change, %	(+TMC 1006, -3)	(+TMC 1006, -3)
	Hardness change, points	(+5, -TMC 1006)	(+5, -TMC 1006)
	Tensile strength change, %	(+10, -45)	(+10, -45)
	Elongation at break change, %	(+20, -30)	(+20, -30)
	Polyacrylate (ACM)		
	Volume change, %	(+5, -3)	(+5, -3)
	Hardness change, points	(+8, -5)	(+8, -5)
	Tensile strength change, %	(+18, -15)	(+18, -15)
	Elongation at break change, %	(+10, -35)	(+10, -35)
	Fluoroelastomer (FKM)		
	Volume change, %	(+5, -2)	(+5, -2)
	Hardness change, points	(+7, -5)	(+7, -5)
	Tensile strength change, %	(+10, -TMC 1006)	(+10, -TMC 1006)
	Elongation at break change, %	(+10, -TMC 1006)	(+10, -TMC 1006)
	Vamac G		
	Volume change, %	(+TMC 1006, -3)	(+TMC 1006, -3)
	Hardness change, points	(+5, -TMC 1006)	(+5, -TMC 1006)
	Tensile strength change, %	(+10, -TMC 1006)	(+10, -TMC 1006)
	Elongation at break change, %	(+10, -TMC 1006)	(+10, -TMC 1006)

Notes:

1. These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the adjusted specification limits described in ASTM D4485 Annex A4.
2. TMC 1006 is the designation for the reference oil used in ASTM D7216. This designation represents the original blend or subsequent approved re-blends of TMC 1006.

[a]See ASTM D4485 Annex A6 for additional information.

[b]MRV requirement listed as a bench test.