هيئة التقييس لدول مجلس التعاون لدول الخليج العربية

GCC Standardization Organization (GSO)

مشروع نهائي

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زيوت تزييت محركات الاحتراق الداخلي – الجزء الثاني: زيوت محركات الجازولين والديزل طبقاً للتصنيف الأوروبي

Lubricating Oils for Internal Combustion Engines – Part 2: ACEA European Oil Sequences for Gasoline Engines and Diesel Engines

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ICS: 75.100

تقديم

هيئة التقييس لدول مجلس التعاون لدول الخليج العربية هيئة إقليمية تضم في عضويتها الأجهزة الوطنية للمواصفات والمقاييس في دول الخليج العربية ، ومن مهام الهيئة إعداد المواصفات القياسية الخليجية بواسطة لجان فنية متخصصة .

وقد قامت هيئة التقييس لدول مجلس التعاون لدول الخليج العربية ضمن برنامج عمل اللجنة الفنية الفرعية رقم (TC07/Sc1) "اللجنة الفرعية لمواصفات المنتجات البترولية" باعداد المواصفة القياسية الخليجية "زيوت تزييت محركات الاحتراق الداخلي – الجزء الثاني: زيوت محركات الجازولين والديزل طبقاً للتصنيف الأوروبي" من قبل (*دولة الإمارات العربية المتحدة*) وقد تم إعداد المشروع بعد استعراض المواصفات القياسية العربية والأجنبية والدولية والمراجع الأخرى المرجعية ذات الصلة.

وقد اعتمدت هذه المواصفة كمواصفة(قياسية / لائحة فنية) خليجية في اجتماع مجلس إدارة الهيئة رقم ( )، الذي عقد بتاريخ / / هـ ، الموافق / / م.

Foreword

GCC Standardization Organization (GSO) is a regional Organization which consists of the National Standards Bodies of GCC member States. One of GSO main functions is to issue GSO Standards / Technical regulations through specialized technical committees (TCs).

GSO through the technical program of sub-committee No TC07/Sc1"*GSO Sub Technical committee for Petroleum Products"* has prepare the standard “Lubricating Oils for Internal Combustion Engines – Part 2: ACEA European Oil Sequences for Gasoline Engines and Diesel Engines”. The Draft Standard has been prepared by (*UNITED ARAB EMIRATES*).

The Draft standard has been prepared based on relevant ADMO, International and National foreign standards and references.

This standard has been approved as a Gulf (Standard / Technical Regulation) by GSO Board of Directors in its meeting No. ( ), held on / / H, / / G. The approved standard will replace and supersede the GSO standard N.(/).

Introduction

ACEA standards recognize that European engines differ from US (style) engines in both their design and operating conditions and that the demands on their oils are also different. This requires the oils used in European engines to be unique and consequently the classification system for them also needs to be unique. For this reason it is difficult to compare the common API classification and ACEA standards as the test sequences for them are quite different

Some ACEA standards also take into account the effect the oil has on engine emissions and emission control systems. This is very much more important for engines that need to meet the much tighter Euro emission standards now applicable in Europe and Australia.

The new ACEA classifications are representing a higher and more current standard of performance as the former CCMC categories.
The European Automobile Manufacturers Associations (ACEA) is the Brussels –based trade association of the 16 major car, van, truck and bus producers in Europe. The ACEA commercial vehicle members are DAF Trucks, Daimler Trucks, IVECO, MAN Trucks & Bus Scania, Volkswagen commercial Vehicles and Volvo Group.

ACEA requires that engine performance testing used to support a claim of compliance with these ACEA sequences should be generated according to the European Engine Lubricants Quality Management System (EELQMS), but ACEA reserves the right to define alternatives in exceptional cases.

The ACEA oil sequences are underlying a constant development. Replacement tests and other changes required by the European automobile manufacturers are integrated and new issues are published on a regular basis. As new editions are published older editions have to be withdrawn. Validities of new and old editions are overlapping for limited periods of time as shown in the following table and the accompanying text below. When a new ACEA sequence is introduced, oils with claims against the previous can be marketed only for another two years.

Sequence Issue	First allowable use	Mandatory for new claims	Oils with this claim May be marketed until
2004	1st November 2004	1st November 2005	31st December 2009
2007	1st February 2007	1st February 2008	23rd December 2010
2008	22nd December 2008	22nd December 2009	22nd December 2012
2010	22nd December 2010	22nd December 2011	22nd December 2014
2012	14th December 2012	14th December 2013	1st December 2018
2016	1stDecember 2016	1st December 2017	……

- First allowable use means that claims cannot be made against the specification before the date indicated.
- Mandatory for new claims means that from this date onward all claims for new oil formulations must be made according to the latest ACEA Oil Sequences Issue. Up to that date new claims can also be made according to the previous ACEA Oil Sequences Issue. After the date indicated no new claims according to the previous ACEA Sequence can be made. Then all oil formulations must be developed according to the latest ACEA release.
- Oils with this claim may be marketed until means that no further marketing of oils with claims to this issue is allowed after the date indicated

The marketer of any oil claiming ACEA performance requirements is responsible for all aspects of product liability.

Lubricating Oils for Internal Combustion Engines – Part 2: ACEA European Oil Sequences for Gasoline Engines and Diesel Engines

1. Scope And Field Of Application

The Gulf standard is concerned with lubricating oils for internal combustion engines suitable for Light duty diesel engine, Engines with after treatment devices and Heavy duty diesel engines excluding marine application.

2. Complementary References

2.1 GSO 126 "Methods of Sampling lubricating Oils".

2.2 GSO 873 "Determination of Apparent Viscosity for Engine Oils at Low Temperature Using the Cold Crank Simulator".

2.3 GSO 896 "Determination of Phosphorous Content in Lubricating Oils and Additives".

2.4 GSO1078 "Determination of Kinematic Viscosity and Dynamic Viscosity for Petroleum Products"

2.5 GSO ISO 2909 "Calculation of Viscosity Index from Kinematic Viscosity".

2.6 GSO ISO 3771 "Determination of Base Number-Perchloric Acid Potentiometric Titration Method".

2.7 GSO ISO 3987 "Petroleum products - Lubricating oils and additives - Determination of sulfated ash"

2.8 GSO ISO 6247 "Determination of Foaming Characteristics of Lubricating Oils".

2.9 GSO ASTM D4684 "Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature"

2.10 GSO 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)"

2.11 GSO ASTM D5293 "Standard Test for Apparent Viscosity of Engine Oils Between -5 and -35°C Using the Cold-Cranking Simulator"

2.12 GSO 1785-1 "Lubricating Oils for Internal Combustion Engines- Part 1: API Classifications"

3. Definition And Abbreviations

3.1 Mineral Base oil: Petroleum product produced after refining, (separating fuel distillates) by extracting asphalt, aromatics, resins, unstable materials, wax and moisture to improve its characteristics.
Also it can be separate mineral oil base types according to whether they are Conventional or hydro-processed. Conventional base oils are refined using traditional methods (applying chemicals) and tend to leave undesirables behind, such as sulfur, oxygen, nitrogen and carbon compounds, and trace metals. These can affect the performance of the oil.
Mineral base oils that have been hydro-processed have undergone additional, more advanced refining processes than their conventional counterparts. The name "hydro-processed" is derived from the fact that refineries use hydrogen reactions (in a process known as hydro-cracking) to remove impurities. When base oils are subjected to even more hydroprocessing, they attain the status of "severe" hydroprocessed oils, which means they contain minimal amounts of impurities.
Hydro-isomerized mineral oils reconstruct cracked waxes into branched paraffin's. This technology is growing globally to meet global standards for lubricants.

3.2 Base stock: Mineral or synthetic oil or mixture of both.

3.3 Additives: Chemical materials designed to be mixed with base stocks to enhance its performance properties.

3.4 Lubrication: The act of adding lubricating oil to reduce friction and wear between the moving parts, to control the increase in temperature rise caused by the friction, to minimize corrosion and to remove residues resulting from internal combustion.

3.5 ACEA: Is the abbreviation for Association des Constructers Europeans de Automobiles (Union of European car manufactures). This committee has developed new classifications for the application of engine oils in gasoline, passenger cars diesel and heavy – duty diesel engines.

3.6 CCMC: Is the abbreviation for Comite des Constructeurs dAutomobiles du Marche Commun.

3.7 ACC: Is the abbreviation for American Chemistry Council.

3.8 EELQMS: Is the abbreviation for European Engine Lubricant Quality Management System.

3.9 CEC: Is the abbreviation for Coordinating European Council

3.10 TWC: Three-Way Catalyst**.**

3.11 EGR: Exhaust Gas recirculation.

3.12 SCR: Selective Catalytic Reduction.

3.13 DPF: Diesel Particulate Filter.

3.14 SAPS: Sulphated Ash, Phosphorus, Sulphur

3.15 HTHS: High Temperature High Shear Viscosity

3.16 DI: Direct Injection

3.17 GPF: Gasoline Particle Filter

4. Classification

Lubricating oils are classified according to their viscosity and performance as follows:

4.1 Classification according to viscosity

Lubricating oils are classified according to viscosity based on SAE classification (see Table 1).

Multigrade oils are the combination of winter (W) and summer grades.

4.2 **Classification according to performance**

Lubricating oils are classified according to performance based on ACEA classification (see Tables 2, 3 &4).

Multigrade oils are the combination of winter (W) and summer grades.

The ACEA 2016 European Oil Sequences for Service-fill Oils comprise 3 sets (classes) of sequences: one for Gasoline and Light Duty Diesel engines; one specifically for Gasoline and Light Duty Diesel engines with after treatment devices and one for Heavy Duty Diesel engines. Within each of these sets there are categories which reflect different performance requirements:

- Four categories (A1/B1, A3/B3, A3/B4 & A5/B5) for gasoline and light duty diesel engines;
- Five categories (C1, C2, C3, C4 & C5) specifically for engines with after treatment devices;
- Four categories (E4, E6, E7 & E9) for heavy duty diesel engines.

Typical applications for each sequence are described below for guidance only.

Specific applications of each sequence are the responsibility of individual engine manufacturers for their own vehicles / engines.

The sequences define the minimum quality level of a product for self-certification to EELQMS and presentation to ACEA members. Performance parameters other than those covered by the tests shown or more stringent limits may be indicated by individual ACEA member companies.

4.2.1 Nomenclature & ACEA Process:

Each set of sequences is designated for consumer use by a 2 part code comprising a letter to define the CLASS (e.g. C), and a number to define the CATEGORY (e.g. C1).

In addition, for industry use, each sequence has a two-digit number to identify the YEAR of implementation of that severity level (e.g. A3 / B4-16).

The CLASS indicates oil intended for a general type of engine – currently there are: A / B = gasoline and light duty diesel engines; C = catalyst compatible oils for gasoline and diesel engines with after treatment devices; E = Heavy Duty Diesel Engines, Other classes

may be added in future if, for example, Natural Gas engines prove to require oil characteristics which cannot readily be incorporated into existing classes.

The CATEGORY indicates oils for different purposes or applications within that general class, related to some aspect or aspects of the performance level of the oil. Typical applications for each sequence are described below for guidance only. Specific applications of each sequence are the responsibility of the individual motor manufacturer for their own vehicles and engines. Oils within a category may also meet the requirements of another category, but some engines may only be satisfied by oils of one category within a class.

The YEAR numbers for ACEA Sequence is intended only for industry use and indicates the year of implementation of that severity level for the particular category. A New Year number will indicate, for example, that a new test, parameter or limit has been incorporated in the category to meet new / upgraded performance requirements whilst remaining compatible with existing applications. An update must always satisfy the applications of the previous issue. If this is not the case, then a new category is required.

An administrative ISSUE Number is added for industry use where it is necessary to update the technical requirements of a sequence without the intention to increase severity (e.g. when a CEC test engine is updated to the latest version whilst maintaining equivalent severity; or where a severity shift in the test requires modification of the specified limits.).

Where claims are made that Oil performance meets the requirements of the ACEA sequences (e.g. product literature, packaging, labels) they must specify the ACEA Class and Category (see Nomenclature & ACEA Process for definitions).

«Consumer Language»:

4.2.1.1 A/B: Gasoline and Diesel Engine Oils

A1/B1 Stable, stay-in-grade oil intended for use at extended drain intervals in gasoline engines and car & light van diesel engines specifically designed to be capable of using low friction low viscosity oils with a high temperature / high shear rate viscosity of 2.6 mPa.s for xW/20 and 2.9 to 3.5 mPa.s for all other viscosity grades. These oils are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

A3/B3 Stable, stay-in-grade oil intended for use in high performance gasoline engines and car & light van diesel engines and/or for extended drain intervals where specified by the engine manufacturer, and/or for year-round use of low viscosity oils, and/or for severe operating conditions as defined by the engine manufacturer.

A3/B4 Stable, stay-in-grade oil intended for use in high performance gasoline and direct injection diesel engines, but also suitable for applications described under A3/B3.

A5/B5 Stable, stay-in-grade oil intended for use at extended drain intervals in high performance gasoline engines and car & light van diesel engines designed to be capable of using low friction low viscosity oils with a High temperature / High shear rate (HTHS) viscosity of 2.9 to 3.5 mPa.s. These oils are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

4.2.1.2 C: Catalyst & GPF/DPF compatible Engine Oils for Gasoline & Diesel Engines – "Low SAPS"

Note: These Oils will increase the DPF/GPF and TWC life and maintain the Vehicle's Fuel Economy.

Warning: Some of these Categories may be unsuitable for use in certain Engine Types – consult the vehicle-OEM's owner's manual/handbook in case of doubt.

C1 Stable, stay-in-grade oil intended for use as catalyst compatible oil in vehicles with DPF and TWC in high performance car and light van diesel and gasoline engines requiring low friction, low viscosity, low SAPS oils with a minimum HTHS viscosity of 2.9 mPa.s.

C2 Stable, stay-in-grade Engine Oil with Mid SAPS-Level, intended for use as catalyst compatible Oil at extended Drain

Intervals in Vehicles with all Types of modern After treatment Systems and High Performance Passenger Car & Light Duty Van Gasoline & DI Diesel Engines that are designed to be capable of using Low Viscosity Oils with a minimum HTHS Viscosity of 2.9 mPa.s.

C3 Stable, stay-in-grade oil intended for use as catalyst compatible oil in vehicles with DPF and TWC in high performance car and light van diesel and gasoline engines, with a minimum HTHS viscosity of 3.5mPa.s.

C4 Stable, stay-in-grade oil intended for use as catalyst compatible oil in vehicles with DPF and TWC in high performance car and light van diesel and gasoline engines requiring low SAPS oil with a minimum HTHS viscosity of 3.5mPa.s.

C5 Stable, stay-in-grade Engine Oil with Mid SAPS-Level, for further improved Fuel Economy, intended for use as catalyst compatible Oil at extended Drain Intervals in Vehicles with all Types of modern After treatment Systems and High Performance Passenger Car & Light Duty Van Gasoline & DI Diesel Engines that are designed to be capable and OEM-approved for use of Low Viscosity Oils with a minimum HTHS Viscosity of 2.6 mPa.s.

4.2.1.3 E: Heavy Duty Diesel engine oils

E4 Stable, stay-in-grade oil providing excellent control of piston cleanliness, wear, soot handling and lubricant stability. It is recommended for highly rated diesel engines meeting Euro I, Euro II, Euro III, Euro IV and Euro V emission requirements and running under very severe conditions, e.g. significantly extended oil drain intervals according to the manufacturer's recommendations. It is suitable for engines without particulate filters, and for some EGR engines and some engines fitted with SCR NOx reduction systems. However, recommendations may differ between engine manufacturers so Driver Manuals and/or Dealers shall be consulted if in doubt.

E6 Stable, stay-in-grade oil providing excellent control of piston cleanliness, wear, soot handling and lubricant stability. It is recommended for highly rated diesel engines meeting Euro I, Euro II, Euro III, Euro IV, Euro V and Euro VI emission requirements and running under very severe conditions, e.g. significantly extended oil drain intervals according to the manufacturer's recommendations. It is suitable for EGR engines, with or without particulate filters, and for engines fitted with SCR NOx reduction systems. E6 quality is strongly recommended for engines fitted with particulate filters and is designed for use in combination with low sulphur diesel fuel. However, recommendations may differ between engine manufacturers so Driver Manuals and/or Dealers shall be consulted if in doubt.

E7 Stable, stay-in-grade oil providing effective control with respect to piston cleanliness and bore polishing. It further provides excellent wear control, soot handling and lubricant stability. It is recommended for highly rated diesel engines meeting Euro I, Euro II, Euro III, Euro IV and Euro V emission requirements and running under severe conditions, e.g. extended oil drain intervals according to the manufacturer's recommendations. It is suitable for engines without particulate filters, and for most EGR engines and most engines fitted with SCR NOx reduction systems. However, recommendations may differ between engine manufacturers so Driver Manuals and/or Dealers shall be consulted if in doubt.

E9 Stable, stay-in-grade oil providing effective control with respect to piston cleanliness and bore polishing. It further provides excellent wear control, soot handling and lubricant stability. It is recommended for highly rated diesel engines meeting Euro I, Euro II, Euro III, Euro IV, Euro V and Euro VI emission requirements and running under severe conditions, e.g. extended oil drain intervals according to the manufacturer's recommendations. It is suitable for engines with or without particulate filters, and for most EGR engines and for most engines fitted with SCR NOx reduction systems. E9 is strongly recommended for engines fitted with

particulate filters and is designed for use in combination with low sulfur diesel fuel. However, recommendations may differ between engine manufacturers so Drivers Manuals and/or Dealers should be consulted if in doubt

5. Characteristics

The lubricating oils shall fulfill the following characteristics:

5.1 The base oil to be used with the additives for lubricating oil production shall be either mineral (paraffinic) base or synthetic base with viscosity index more than 90.

5.2 Nor-refined or recycled oil base oils to be used in formulating these lubricants unless these oils are produced by internationally recognized licensed processes and the base oil products have the same quality of virgin Base Oils.

5.3 They shall contain some anti-oxidation, anti-rust, anti-corrosion, anti-wear, anti-foam, detergents/dispersants and pour point depressant additives and other additives, etc. to improve the quality and meet performance requirements of Tables 2, 3 and 4.

5.4 The additives (item 5.3), to be used shall be completely soluble in the base oil. They shall neither partly precipitate nor separate if the temperature raised to 125 °C.

5.5 They shall be homogeneously mixed, bright and clear and have acceptable odour.

5.6 The oils shall be stable and compatible.

5.7 They shall be free from water, sediments, dusts, abrasive matter and impurities

5.8 They shall fulfill the pour point and flash point requirements of Table 5.

6 Sampling

Samples shall be drawn according to Standard mentioned in item (2.1).

7 Methods of Testing*

The following tests shall be carried out according to the performance and application requirement and the representative sample taken in accordance with item (6).

***Note:** The tests shall be carried out according to the Gulf Standards given in item (**2**) or equivalents and according to international test methods standards (ISO or ASTM or CEC)*

7. 1 Physical & Chemical Tests

7.1.1 Visual inspection.
7.1.2 Determination of flash point.
7.1.3 Determination of kinematic viscosity and dynamic viscosity.
7.1.4 Calculation of viscosity index.
7.1.5 Determination of pour point.
7.1.6 Determination of phosphorus content.
7.1.7 Determination of zinc content.
7.1.8 Determination of calcium content.
7.1.9 Determination of magnesium content.
7.1.10 Determination of sulphated ash.
7.1.11 Determination of nitrogen content.
7.1.12 Determination of total base number and total acid number.
7.1.13 Determination of foaming characteristics of lubricating oils
7.1.14 Determination of stability and compatibility.
7.1.15 Determination of homogenously solubility.
7.1.16 Determination of apparent viscosity.
7.1.17 Determination of pumping viscosity.
7.1.18 Determination of conradson carbon residue.
7.1.19 Determination of sulfur content**.**

7.2 Engine and Bench Tests

For the evaluation of lubricating oils used in internal combustion engines, as listed in below Tables.

8 Packing

Lubricating oils shall be packed in tightly closed and sealed containers preventing possibilities of oil leakage or oil contamination with any impurities; such containers neither shall affect nor be affected by the oil.

9 Labelling

The following information shall be legibly and indelibly marked in both Arabic and English languages on each container of lubricating oils.

9.1 Net volume, in liters.
9.2 Producer's name or his registered trade mark.
9.3 Name of the country of origin.
9.4 The classification of oils according to SAE viscosity, and ACEA performance (as in item 4) and its intended use.
9.5 Date of production and the batch number or barcode to follow product in market.
9.6 Precaution: "Avoid Environmental Pollution".
9.7 Base Oil origin: virgin base oil or recycled.

10 Rules For Acceptance And Rejection

10.1 Each consignment of lubricating oils shall be accompanied with a certificate stating its compliance with this standard.

10.2 The consignment shall be considered complying with this Gulf standard when the accompanying certificate is accepted.

10.3 In case the certificate is not accepted (because information is incomplete or subject to question), the information may be completed or (if necessary) substantial test mentioned in item (7.1) shall be carried out on samples taken in accordance with all the requirements of this standard. When the withdrawn samples pass the entire test the consignment shall be considered as complying with this Gulf standard. In case one or more of the lubricating oil samples fail to pass any of the tests, a second sample, double the number of samples of the first one shall be withdrawn from the same group and subjected to all the tests.

The consignment shall be considered as complying with the requirements of this standard when all the test samples of the second sample pass the re-tests. Otherwise the consignment shall be considered as not complying

REFERENCES

Main Reference

- **European Automobile Manufacturers Association , ACEA 2016 European Oil Sequences for Service-Fill Oils**

- **Recommended Practices and Information Reports of Society of Automotive Engineers (SAE):**
  SAE J 300 / Jan 2015 "Engine Oil Viscosity Classification"

Other References

- **Society of Automotive Engineers (SAE):**
  SAE J357/2016 "Physical and Chemical Of Engine Oils"
  SAE J304/2016 "Engine Oil Tests"
  SAE J183/2016 "Engine Oil Performance and Engine Service Oils"

Table (1)

SAE VISCOSITY GRADES FOR ENGINE OILS (1) (2) *

SAE Viscosity Grade	Low –temperature (°C) Cranking Viscosity (3), mPa.s	Low temperature (°C) Pumping Viscosity (4), mPa.s with no yield stress	Low-Shear-Rate Kinematic Viscosity (5) (mm2/s) at 100 °C		High-shear-Rate Viscosity (6) mPa.s at 150 °C,
	Max.	Max.	Min.	Max.	Min.
0 W**	6200 at -35	60 000 at -40	3.8	-	-
5 W	6600 at -30	60 000 at -35	3.8	-	-
10 W	7000 at -25	60 000 at -30	4.1	-	-
15 W	7000 at -20	60 000 at -25	5.6	-	-
20 W	9500 at -15	60 000 at -20	5.6	-	-
25 W	13000 at -10	60 000 at -15	9.3	-	-
8	-	-	4.0	< 6.1	1.7
12	-	-	5.0	< 7.1	2.0
16	-	-	6.1	< 8.2	2.3
20	-	-	6.9	< 9.3	2.6
30	-	-	9.3	< 12.5	2.9
40	-	-	12.5	< 16.3	3.5 (0W-40, 5W-40 and 10W-40 grades)
40	-	-	12.5	< 16.3	3.7(15W-40,20W-40, 25W-40, 40 mono grades)
50	-	-	16.3	< 21.9	3.7
60	-	-	21.9	< 26.1	3.7

(1) Notes: 1 mPa.s =1 cP; 1 mm^2/s = 1 cSt

(2) All values, with the exception of the low- temperature cranking viscosity are critical specification as defined by ASTM D3244

(3) ASTM D5293: Cranking viscosity- The non-critical specification protocol in ASTM D3244 shall be applied with a P value of 0.95.

(4) ASTM D4684**:** Note that the presence of any yield stress detectable by this method constitutes a failure regardless of viscosity.

(5) ASTM D445.

(6) ASTM D4683, ASTM D4741, ASTM D5481 or CEC L-36- 90.

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* * **W**: Is symbol for winter

Table (2)

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members. Performance parameters other than those covered by the tests shown or more stringent limits may be indicated by individual member companies.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				A3 / B3-16	**A3 / B4-16**	**A5 / B5-16**	
1. LABORATORY TESTS							
1.1 Viscosity grades		Viscosity Class according to SAE J300- Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 * Shear stability	CEC L -014-93 or ASTM D6278 or ASTM D7109	Kinematic Viscosity at 100°C after 30 cycles	mm^2/s	All grades to be "stay in grade"			
1.3.1 HTHS Viscosity	CEC L-036-90	Dynamic Viscosity at 150 °C and Shear Rate of 10^6 s^{-1}	mPa.s	≥ 3.5		≥ 2.9 & ≤ 3.5	
1.3.2 HTHS Viscosity at 100°C	CEC L-036-90	Dynamic Viscosity at 100 °C and Shear Rate of 10^6 s^{-1}	mPa.s	--		Report	
1.4 Evaporative loss	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250 °C	%	≤ 13			
1.5 TBN	ASTM D 2896		mgKOH/g	≥ 8.0	≥ 10.0	≥ 8.0	
1.6 * Sulphur	ASTM D5185		% m/m	Report			
1.7 * Phosphor	ASTM D5185		% m/m	Report			
1.8* Sulphated ash	ASTM D874		**% m/m**	≥ 0,9 and ≤ 1.5	≥ 1,0 and ≤ 1.6	≤ 1.6	
1.9 Chlorine	ASTM D6443		ppm m/m	Report			
1.10 * Oil - elastomer compatibility	CEC L-112-16	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing: - Tensile Strength - Elongation at Rupture - Volume Variation	Elastomer Points % % %	RE6 Report -70/+20 -5.5/+2.1	RE7 Report -65/+15 -1.8/+8.9	RE8 Report -51/+9 0.0/+12.0	RE9 Report -65/+19 2.5/+16.0
1.11 Foaming tendency	ASTM D892 without option A	Tendency - stability	ml	Sequence I (24°C) 10 - nil Sequence II (94°C) 50 - nil Sequence III (24°C) 10 - nil			
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150 °C) 100 – nil			
1.13 Low Temperature Pumpability	CEC L-105-12	MRV Yield stress (MRV at SAE J300 Temperatures, applicable for the Fresh Oil Viscosity Grade)	mPa.s Pa	According to SAE J300 for Fresh Oil			
1.14 * Oxidation with biodiesel	CEC L-109-16	Oil Oxidation at 168h (DIN 51453) Oil Oxidation at 216h (EOT) (DIN 51453) Viscosity Increase, relative at 168h (Delta KV100) Viscosity Increase, relative at 216h (Delta KV100 at EOT 216h)	A/cm A/cm % %	≤ 120 Report ≤150 Report	≤ 120 Report ≤150 Report	≤ 100 ≤ 120 ≤ 60 ≤ 150	

Table (2)……Continue

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members. Performance parameters other than those covered by the tests shown or more stringent limits may be indicated by individual member companies.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS		
				A3 / B3-16	**A3 / B4-16**	**A5 / B5-16**
2. ENGINE TESTS						
2.1 Gasoline DI Engine Cleanliness	CEC L-111-16 (EP6CDT)	Piston Cleanliness	Merit	≥ RL259		
		Turbo Charger Deposits **, average value of zones C, D, E & F	Merit	≥ 6.0		
2.2 * Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API	Average engine sludge	merit	≥ 7.8		
		Rocker cover sludge	merit	≥ 8.0		
		Average Piston skirt varnish	merit	≥ 7.5		
		Average engine varnish	merit	≥ 8.9		
		Comp. ring (hot stuck)		none		
		Oil screen clogging	%	≤ 20		
2.3 Valve train scuffing wear						
2.4 * Black sludge	Daimler M271	Engine sludge, average	merit	≥ RL 140 + 4σ		
2.5 * Fuel Economy	CEC L-054-96 (M111)	Fuel economy improvement	%	-- --		≥ 2.5
2.6 DI Diesel Oil Dispersion at Medium Temperature	CEC L-106-16 (DV6C)	Absolute viscosity increase at 100 °C and 5.5 % Soot	mm^2/s	≤ 0.9 x RL248		
		Piston Cleanliness **	merit	≥ 2,5		
2.7 Diesel Engine Wear	CEC L–099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 140	≤ 120	
		Cam wear inlet (avg. max. wear 8 cams) **	µm	≤ 110	≤ 100	
		Cylinder wear (avg. 4 cylinders) **	µm	≤ 5.0	≤ 5.0	
		Bore polishing (13 mm) ** (max. value of 4 cylinders)	%	≤ 3.5	≤ 3.0	
		Tappet wear inlet ** (avg. max. wear 8 cams)	µm	Report	Report	
		Tappet wear outlet ** (avg. max. wear 8 cams)	µm	Report	Report	
		Piston cleanliness (avg. 4 pistons) **	Merit	Report	≥ 12	
		Engine sludge average **	Merit	Report	≥ 8.8	
2.8 * DI Diesel Piston Cleanliness & Ring Sticking	CEC L-078-99 (VW TDI)	Piston Cleanliness	Merit	≥ RL206	≥ RL206	≥ RL206 ≤ 100
		Ring sticking (Rings 1 & 2)	ASF	minus		
		Average of all 8 rings	ASF	4 points		
		Max. for any 1st ring	ASF	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 2nd ring	mgKOH/g	≤ 2.5	≤ 1.0	≤ 1.0
		EOT TBN (ISO 3771) **	mgKOH/g	0.0	0.0	0.0
		EOT TAN (ASTM D664) **	s	≥ 4.0	≥ 6.0	≥ 4.0
				Report	Report	Report
2.9 Effects of Biodiesel	CEC L-104-16 (OM646LA Bio)	Piston cleanliness	Merit		≥ RL255+2	
		Ring sticking**	ASF		Report	
		Sludge **	Merit		Report	

***/**: Footnote information see last page of the C-Categories.**

Table (3)

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members. Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				C1-16	C2-16	C3-16	C4-16	C5-16
1. LABORATORY TESTS								
1.1 Viscosity grades		Viscosity Class according to SAE J300 - Latest active issue		No restriction except as defined by HTHS and Shear Stability requirements. Manufacturers may indicate specific Viscosity requirements related to ambient temperature.				
1.2 * Shear stability	CEC L-014-93 or ASTM D6278 or ASTM D7109	Kinematic Viscosity at 100 °C after 30 cycles	mm^2/s	All grades to be stay in grade				
1.3.1 HTHS Viscosity	CEC L-036-90	Dynamic Viscosity at 150 °C and Shear Rate of 106 s-1	mPa.s	≥ 2.9		≥ 3.5		≥ 2.6 & < 2.9
1.3.2 * HTHS Viscosity at 100 °C	CEC L-036-90	Dynamic Viscosity at 100 °C and Shear Rate of 10^6 s^{-1}	mPa.s	Report		Report		Report
1.4 Evaporative loss	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250°C	%			≤ 13	≤ 11	≤ 13
1.5 TBN	ASTM D 2896		mg KOH/g	---		≥ 6.0	≥ 6.0	≥ 6.0
1.6 * Sulphur	ASTM D5185		% m/m	≤ 0.2	≤ 0.3		≤ 0.2	≤ 0.3
1.7 * Phosphor	ASTM D5185		% m/m	≤ 0.05	≥ 0.07 ≤ 0.09	≥ 0.07 ≤0.09	≤ 0.090	≥ 0.07 ≤0.09
1.8 * Sulphated ash	ASTM D874		**% m/m**	≤ 0.5	≤ 0.8		≤ 0.5	≤ 0.8
1.9 Chlorine	ASTM D6443		ppm m/m	Report				
1.10 * Oil - elastomer compatibility	CEC L-112-16	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing - Tensile strength - Elongation at rupture - Volume variation	Elastomer % % %	RE6 Report -70/+20 -5.5/ +2.1		RE7 Report -65/+15 -1.8/ +8.9	RE8 Report -51/+9 0.0/ +12	RE9 Report -65/+119 -2.5/ +16.0
1.11 Foaming Tendency	ASTM D892 without option A	Tendency - stability	ml	Sequence I (24°C) 10 - nil Sequence II (94°C) 50 - nil Sequence III (24°C) 10 - nil				
1.12 High Temperature Foaming Tendency	ASTM D6082 High Temperature Foam Test	Tendency - stability	ml	Sequence IV (150°C) 100 – nil				
1.13 Low-Temperature Pumpability	CEC L -105-12	MRV Yield stress (MRV at SAE J300 Temperatures, applicable for the Fresh Oil Viscosity Grade)	mPa.s Pa	According to SAE J300 for Fresh Oil				
1.14 Oil Oxidation with Biodiesel for Engine Oils operating in the presence of Biodiesel Fuel	CEC L-109-16	Oil Oxidation at 168 h (DIN 51453) Oil Oxidation at 216 h (EOT) (DIN 51453) Viscosity Increase, relative at 168 h (Delta KV100) Viscosity Increase, relative at 216 h (Delta KV100 at EOT 216 h)	A/cm A/cm % %	≤ 100 ≤ 120 ≤ 60 ≤ 150	≤ 100 ≤ 120 ≤ 60 ≤ 150	≤ 100 ≤ 120 ≤ 60 ≤ 150	≤ 100 ≤ 120 ≤ 60 ≤ 150	≤ 100 ≤ 120 ≤ 60 ≤ 150

Table (3) …… Continue.

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members.
Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				C1-16	C2-16	C3-16	C4-16	C5-16
2. ENGINE TESTS								
2.1 Gasoline DI Engine Cleanliness	CEC L-111-16 (EP6CDT)	Piston Cleanliness Turbo Charger Deposits **, average value of zones C, D, E & F	Merit Merit	≥ RL 259 ≥ 6.0				
2.2 * Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API	Average engine sludge Rocker cover sludge Average Piston skirt varnish Average engine varnish Comp. ring (hot stuck) Oil screen clogging	merit merit merit merit %	≥ 7.8 ≥ 8.0 ≥ 7.5 ≥ 8.9 none ≤ 20				
2.3 Valve train scuffing wear								
2.4 * Black sludge	Daimler M271	Engine sludge, average	merit	≥ RL 140 + 4σ				
2.5 * Fuel economy	CEC L-054-96 (M111)	Fuel economy improvement	%	≥ 3.0	≥ 2.5	≥ 1.0 (for xW-30 only. no limit for xW-40)		≥ 3.0
2.6 DI Diesel Oil Dispersion at Medium Temperature	CEC L-093-04 (DV4TD) To be replaced by DV6	Absolute viscosity increase at 100 °C and 6 % soot Piston merit	mm²/s merit	≤ 0.9 x RL248 ≥ 2.5				
2.7 Diesel Engine Wear	CEC L-099 - 08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams) Cam wear inlet (avg. max. wear 8 cams) ** Cylinder wear (avg. 4 cylinders) ** Bore polishing (13 mm) ** (max. value of 4 cylinders) Tappet wear inlet ** (avg. max. wear 8 cams) Tappet wear outlet ** (avg. max. wear 8 cams) Piston cleanliness (avg. 4 pistons) ** Engine sludge average **	µm µm µm % µm µm merits merits	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report report report	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report report report	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report ≥ 12 ≥ 8,8	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report ≥ 12 ≥ 8,8	
2.8 * DI Diesel Piston Cleanliness & Ring Sticking	CEC L-078-99 (VW TDI)	Piston cleanliness Ring sticking (Rings 1 & 2) Average of all 8 rings Max. for any 1st ring Max. for any 2nd ring EOT TBN (ISO 3771) ** EOT TAN (ASTM D 664) **	merits ASF ASF ASF mgKOH/g mgKOH/g	≥ RL206 ≤ 1.0 ≤ 1.0 0.0 report report	≥ RL206 ≤ 1.2 ≤ 2.5 0.0 report report	≥ RL206 ≤ 1.0 ≤ 1.0 0.0 report report	≥ RL206 ≤ 1.0 ≤ 1.0 0.0 report report	
2.9 Effects of Biodiesel	CEC L-104-16 (OM646LA Bio)	Piston Cleanliness Ring Sticking** Sludge **	merits ASF merits	≥RL206 Report Report				

***/**: Footnotes referring to the following Requirements in the A-/B- and C-Classes:**

No. 1.2 Referring to the latest Version of the SAE J300 the minimum Viscosity for xW-20 Oils after Shearing is 6.9 cSt
No. 1.3.2 The CEC-L036-90 method is not yet approved for the parameter HTHS at 100 °C.
No. 1.6, 1.7, 1.8 Maximum limits, Values take into account method and production tolerances
No. 1.6, 1.7 Internal standard method must be used.

No. 1.10	For Categories A3/B3, A3/B4, A5/B5 and C1, C2, C3, C4: Available Test data from the Predecessor-Test CEC L-039-96 may be used for ACEA 2016 instead of CEC L-112-16 under the condition that a Full L-039 Data set including RE1, RE2, RE3 & RE4 + the Daimler DBL-AEM (requirements as specified by Daimler AG), provided the requirements as specified in ACEA 2012 are met.
No. 2.1, 2.6 2.9	** Parameter is not an official CEC Parameter
No. 2.2	The limits shown are based on those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants. Once the successor Test Seq. VH, which is currently still under development, is fully ASTM approved, the Seq. VH may be run with Limits officially communicated by ACEA.
No. 2.3	The CEC L-038-94 (TU3M) Test was removed from these Oil Sequences since hardware will run out in early 2017. However, in order to assure/support Wear Protection although TU3 is removed, ACEA intends to introduce the ASTM Seq. IVB Test as a TU3-Sucessor regarding valve train wear with the next Oil Sequences Revision, with Limits for Seq. IVB then to be defined based on ILSAC Spec.
No. 2.4	Until the new CEC Test Method L-107 is fully developed, the Gasoline Sludge Protection Performance of Engine Oil Formulations must be proven by the M271 Sludge Test procedure as described by Daimler AG. Test results obtained by the M271 procedure will be accepted only under the condition that they come from Test Rigs being referenced and quality controlled by Daimler AG. Limits are based on the same Reference Oil as with the old M111 Sludge Test. Once the L-107 Procedure is fully CEC-approved, the L-107 may be used, with limits officially communicated by ACEA.
No. 2.8 *	Test Report must give measured values before & after the test, all measurements to be taken in the same lab. Note: EOT TAN is considered to become performance criteria in the future. Any test run prior to the publication of the ACEA 2012 Oil Sequences can be used whether or not it has data for EOT TAN.

Table (4)

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members.
Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-16	**E6-16**	**E7-16**	**E9-16**
1. LABORATORY TESTS							
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC L-014-93 or ASTM D6278 Or ASTM D7109	Kinematic Viscosity at 100 °C after 30 cycles	mm^2/s	Stay in grade			
	ASTM D7109	Kinematic Viscosity at 100 °C after 90 cycles	mm^2/s		Stay in grade		
1.3 HTHS Viscosity	CEC L-036-90	Dynamic Viscosity at 150 °C And Shear Rate 10^6 s^{-1}	mPa.s	≥ 3.5			
		Dynamic Viscosity at 100 °C and Shear Rate of 10^6 s^{-1}	mPa.s	Report			
1.4 Evaporative loss	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250 °C	%	≤ 13			
1.5 Sulphated Ash	ASTM D874		% m/m	≤ 2.0	≤ 1.0	≤ 2.0	≤ 1.0
1.6 * Phosphorus	ASTM D5185		% m/m		≤ 0.08		≤ 0.12
1.7 * Sulphur	ASTM D5185		% m/m		≤ 0.3		≤ 0.4
1.8* Oil / Elastomer Compatibility	CEC L-112-16	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing Tensile strength Elongation rupture Volume variation	 % % %	RE6 Report -70/+20 -5.5/+2.1	RE7 Report -65/+15 -1.8/+8.9	RE8 Report -51/+9 0.0/+12	RE9 Report -65/+19 -2.5/+16
1.9 Foaming Tendency	ASTM D892 without option A	Tendency - stability	ml	Sequence I (24°C) 10 - nil Sequence II (94°C) 50 - nil Sequence III (24°C) 10 - nil			Seq I 10/0 Seq II 20/0 Seq III 10/0
1.10 High Temperature Foaming Tendency	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150°C) 200 – 50			
1.11 Oxidation	CEC L-085-99 (PDSC)	Oxidation induction time	min	≥ 65			
1.12 Corrosion	ASTM D 6594	Copper increase Lead increase Copper strip rating	ppm ppm max	Report Report Report		Report ≤ 100 Report	≤ 20 ≤ 100 3
1.13 * TBN	ASTM D2896		mg KOH/g	≥12	≥ 7	≥ 9	≥ 7
1.14 Low temperature pump ability	CEC L-105	MRV Yield stress (MRV at SAE J300 temperatures applicable for the fresh oil viscosity grade)	mPas Pa	According to SAE J300 for fresh oil			
1.15 Oil Oxidation with Biodiesel	CEC L-109-16	Oxidation increase after 168 h KV100 increase after 168 h	A/cm %	≤ 90 ≤ 130	≤ 80 ≤ 130	≤ 120 ≤ 300	≤ 90 ≤ 150

Table (4) …… Continue

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members.
Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-16	**E6-16**	**E7-16**	**E9-16**
2. ENGINE TESTS							
2.1* Wear	CEC L-099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	**≤ 140**	**≤ 140**	**≤ 155**	**≤ 155**
2.2 * Soot in oil	ASTM D 5967 (Mack T-8E)	Test duration 300 h Relative viscosity at 4.8% soot and 50% shear loss 1 test/2 test/3 test average		**≤ 2.1/2.2/2.3**	**≤ 2.1/2.2/2.3**	**≤ 2.1/2.2/2.3**	**≤ 2.1/2.2/2.3**
2.3 * Bore Polishing Piston Cleanliness	CEC L-101-08 (OM501LA)	Piston cleanliness, average Bore polishing, average ** Oil consumption ** Engine sludge, average **	Merit % kg/Test Merit	**≥ 26** **≤ 1.0** **≤ 9** **Report**	**≥ 26** **≤ 1.0** **≤ 9** **Report**	**≥ 17** **≤ 2.0** **≤ 9** **Report**	**≥ 17** **≤ 2.0** **≤ 9** **Report**
2.4 * Soot Induced Wear	ASTM D7468 (Cummins ISM	Merit Crosshead, weight loss 1 test/2 test/3 test average Oil Filter Diff. Press at 150h 1 test/ 2 test/3 test average Engine sludge 1 test/2 test/3 test average Adj. screw weight loss	 mg kPa Merit mg			 **≤ 7.5/7.8/7.9** **≤ 55/67/74** **≥ 8.1/8.0/8.0**	**≤ 2.0** **≥ 17** **≤ 9** **R&R**
2.5 * Wear (liner-ring-bearings)	ASTM D7422 (Mack T12)	Merit Cylinder liner wear (CLW) Top ring weight loss (TRWL) End of test lead Delta lead 250-300 hrs Oil consumption (Phase II)	µm mg ppm ppm g/hr		**≥ 1000** **≤ 26** **≤ 117** **≤ 42** **≤ 18** **≤ 95**	**≥ 1000** **≤ 26** **≤ 117** **≤ 42** **≤ 18** **≤ 95**	**≥1000** **≤ 24** **≤ 105** **≤ 35** **≤ 15** **≤ 85**
2.6 * Biofuel Impacted Piston Cleanliness and Engine Sludge	CEC L-104-16 (OM646LA Bio)	Piston cleanliness, average Ring sticking ** Engine sludge, average **	Merit ASF Merit		**≥ RL255 + 4** **Report** **Report**		**≥ RL255 + 2** **Report** **Report**

*/**: Footnotes referring to the following requirements in the E-Class:

No. 1.8 Full Data sets being obtained on CEC L-039-96 + the Daimler requirements for DBL-AEM as specified by Daimler AG can be used instead of CEC L-112-16, provided the requirements as specified in ACEA 2012 are met.

No. 1.13 For E7, values < 9.00 are not accepted.

No. 2.2 Mack T11 results obtained as part of an API CI-4, CI-4 plus, CJ-4, CK-4 or FA-4 approval program, can be used in placeof Mack T8E.

No. 2.3, 2.6 ** Not CEC approved parameters.

No. 2.4 Merit number shall be calculated according to the API CI-4 specification

No. 2.5 For E6 & E7 Merit number shall be calculated according to the API CI-4 specification.

For E6 & E7 Mack T10 results obtained as part of an API CI-4 or CI-4 plus approval program, can be used in place of Mack T12. Mack T-12 Cylinder Liner Wear and Top Ring Weight Loss results obtained as part of an API CK-4 or FA-4 approval program, which includes a passing Volvo T-13 at the API CK-4 or API FA-4 level, may be used to satisfy the requirements of the Mack T-12 in the ACEA Oil Sequences.

Table (5)
Pour Point and Flash Point of Engine Oils

Oil Grades	Pour Point °C (max.)	Flash Point °C (min.)
0 W*	-39	185
5 W	-36	195
10 W	-33	205
15 W	-27	210
20 W	-24	215
25 W	-24	220
20	-21	215
30	-18	220
40	-15	230
50	-9	235
60	-9	240

* **W**: Is Symbol for winter

- For the multi-grades, the selected pour point shall be in line with the "**W**" oil grades

- For the multi-grades, the selected flash point shall be in line with the middle point of the oil grades (as min.)