ACEA
European Automobile Manufacturers Association

ACEA EUROPEAN OIL SEQUENCES

2012

SERVICE FILL OILS FOR
GASOLINE ENGINES
LIGHT DUTY DIESEL ENGINES
ENGINES WITH AFTER TREATMENT DEVICES and
HEAVY DUTY DIESEL ENGINES

Laboratory tests for gasoline and light duty diesel engine oils,
Engine tests for gasoline and light duty diesel engine oils,
Laboratory tests for engine with after treatment devices,
Engine tests for engine with after treatment devices,
Laboratory tests for heavy duty diesel engine oils,
Engine tests for heavy duty diesel engine oils.

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This document details the ACEA 2012 European Oil Sequences for Service-fill Oils for Gasoline engines, for Light Duty Diesel engines, for Gasoline & Diesel engines with after treatment devices and for Heavy Duty Diesel engines. These sequences define the minimum quality level of a product 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.

These sequences will replace the ACEA 2010 sequences as a means of defining engine lubricant quality from 1st December 2012.

CONDITIONS FOR USE OF PERFORMANCE CLAIMS AGAINST THE ACEA OIL SEQUENCES

ACEA requires that any claims for Oil performance to meet these sequences must be based on credible data and controlled tests in accredited test laboratories.

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.
EELQMS which is described in the ATIEL Code of Practice[1], addresses product development testing and product performance documentation, and involves the registration of all candidate and reference oil testing and defines the compliance process. Compliance with the ATIEL Code of Practice is mandatory for any claim to meet the requirements of the 2012 issue of the ACEA sequences. Therefore ACEA requires that claims against the ACEA oil sequences can only be made by oil companies or oil distributors who have signed the EELQMS oil marketers' Letter of Conformance (for details: www.atiel.org).

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	...

Table: For the 2012 issue of the ACEA Oil Sequences: First claims can be made from 14th December 2012. For another year (until 14th December 2013), oil marketers can still make new claims against ACEA 2010. Starting with 14th December 2013 every new claim has to be made against the 2012 ACEA Oil Sequences. All engine oils using claims against the 2010 ACEA Sequences can be continued to be marketed until 22nd December 2014.

- 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 Sequence Issue. Up to that date new claims can also be made according to the previous ACEA Sequence Issue. After the date indicated no new claims 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 an oil claiming ACEA performance requirements is responsible for all aspects of product liability.

Where limits are shown relative to a reference oil, then these must be compared to the last valid Reference Result on that test stand prior to the candidate and using the same hardware. Further details will be in the ATIEL Code of Practice.

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).

[1] The ATIEL Code of Practice is the sole property of ATIEL and is available from ATIEL (Association Technique de l'Industrie Européenne des Lubrifiants), Boulevard du Souverain 165, B-1160 Brussels, Belgium.

CERTIFICATION and REGISTRATION

Claims against the ACEA Oil Sequences can be made on a self-certification basis. ACEA asks oil marketers wishing to use the ACEA claims to register their product with the registration system on the ACEA website.

All information needed for registration is requested on an electronic form which is available at the following ACEA webpage:

http://acea.dossier-on-web.com/eor/engine-oil-registrations/menu/eor/front-page

Engine Oils claiming any of the ACEA oil sequences should be registered directly after their launch into the market. After completing the form, the data will be saved on the ACEA server. If claims are no longer needed oil companies are asked to delete their registration.

If claims are continued to be used after three years re-registration is required.

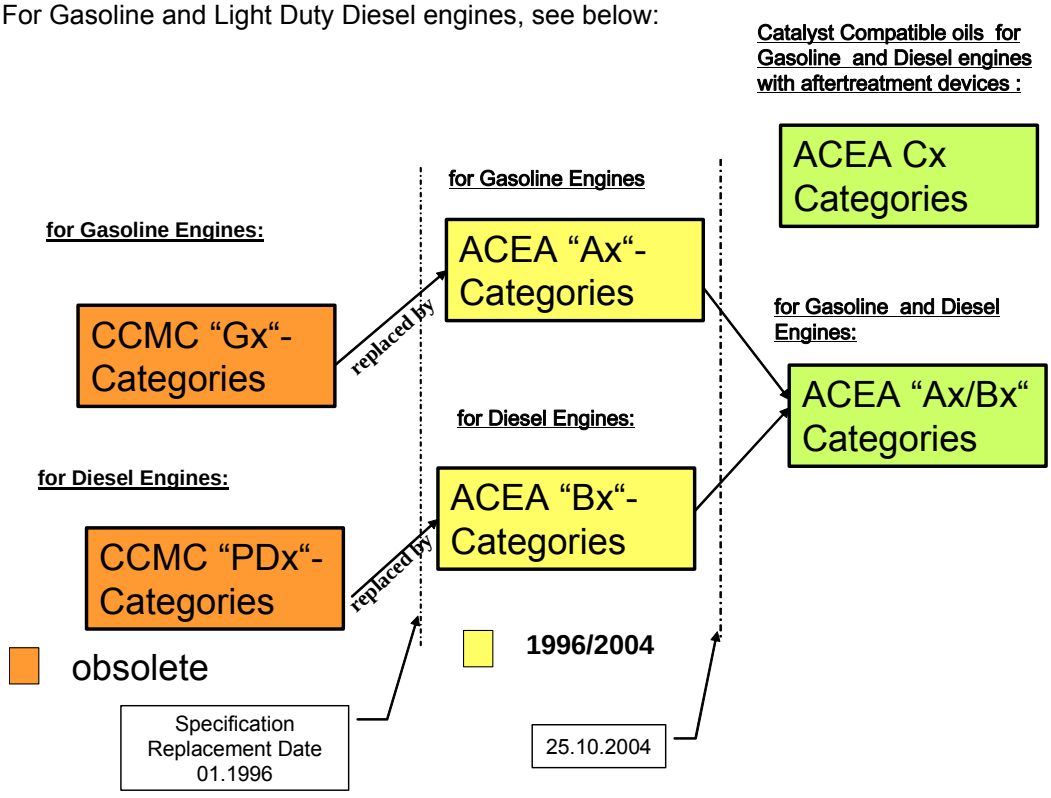
REPLACEMENT of CCMC sequences

The chart below shows the evolution of the engine oil specifications commonly developed by the European Automobile manufacturers. CCMC (Comité des Constructeurs du Marché Commun) was the forerunner organisation to ACEA.

In January 1996 the CCMC European Oil Sequences became obsolete and were replaced by the ACEA European Oil Sequences. This is true for light duty engine oils as well as heavy duty engine oils. CCMC European Oil Sequences are not supported any more by ACEA.

With the 2004 release of the ACEA European Oil Sequences the A and B categories have been combined to the respective A/B categories. At the same time, a new set of categories has been introduced with the intention to create specifications for engine oils being suitable for the latest and future aftertreatment systems for Gasoline and Diesel engines. These categories are designated as Cx-categories.

For Heavy Duty Diesel engines, the CCMC Dx categories were replaced by the ACEA Ex categories as of 1 January 1996. The CCMC Dx categories then became obsolete and are no longer supported by ACEA.
For Gasoline and Light Duty Diesel engines, see below:



X= 1, 2, 3, 4 or 5 depending of categories

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCES FOR SERVICE-FILL OILS	Dec. 2012

The ACEA 2012 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 (A1/B1, A3/B3, A3/B4 & A5/B5) for gasoline and light duty diesel engines; four (C1, C2, C3, C4) specifically for engines with after treatment devices, and four (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.

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. A1 / B1-04).

The CLASS indicates oil intended for a general type of engine - currently A / B = gasoline and light duty diesel engines; C = catalyst compatible oils for gasoline and diesel engines with after treatment devices. 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»:

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.

C : Catalyst compatibility oils

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. These oils will increase the DPF and TWC life and maintain the vehicles fuel economy.

Warning: these oils have the lowest SAPS limits and are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

C2 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 designed to be capable of using low friction, low viscosity oils with a minimum HTHS viscosity of 2.9mPa.s. These oils will increase the DPF and TWC life and maintain the vehicles fuel economy.

Warning: these oils are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

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. These oils will increase the DPF and TWC life.

Warning: these oils are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

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. These oils will increase the DPF and TWC life.

Warning: these oils are unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

SAPS : Sulphated Ash, Phosphorus, Sulphur
DPF : Diesel Particulate Filter
TWC : Three way catalyst
HTHS : High temperature / High shear rate viscosity

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 NO_x 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 NO_x reduction systems. E9 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 Drivers Manuals and/or Dealers should be consulted if in doubt

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE and DIESEL ENGINES	Dec. 2012

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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			
				A1 / B1-12	**A3 / B3-12**	**A3 / B4-12**	**A5 / B5-12**
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	100°C Viscosity after 30 cycles	mm^2/s	xW-20 ≥ 5.6 xW-30 ≥ 9.3 xW-40≥ 12.0	All grades to be stay in grade		
1.3 Viscosity at high temp. & high shear rate	CEC L-036-90	Viscosity at 150°C and 10^6 s^{-1} shear rate	mPa.s	≥ 2.9 and ≤ 3.5; xW-20: 2.6. min	≥ 3.5		≥ 2.9 and ≤ 3.5
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	≥ 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**	≤ 1.3	≥ 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-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type			
				RE1	RE2-99	RE3-04	RE4	DBL-AEM
		Hardness DIDC	points	-1/+5	-5/+8	-22/ +1	-5/+5	-5/+10
		Tensile strength	%	-40/+10	-15/+18	-30/+10	-20/+10	-35/ -
		Elongation at rupture	%	-50/+10	-35/+10	-20/+10	-50/+10	-50/ -
		Volume variation	%	-1/+5	-7/+5	-1/+22	-5/+5	-5/+15
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 (150oC) 100 – nil				
1.13 * Oxidation in presence of biodiesel	GFC-Lu-43A-11	Catalysed ageing test until 144h at 170°C & with air bubbling: 1. on pure oil 2. with B10 added (B71 1892 GO B10 LUB) PAI at 144h Kin. viscosity @ 100°C variation: - at 72h - at 96h - at 120h - at 144h	 % cSt & % cSt & % cSt & % cSt & %					Report Report Report Report Report and at 144h: < +200% (no solidification)
1.14 Low-Temperature Pumpability	CEC L-105	MRV Yield stress (MRV at SAE J300 temperatures applicable for the fresh oil viscosity grade)	mPas Pa	Acc to SAE J300 for fresh oil		Acc to SAE J300 for fresh oil	Acc to SAE J300 for fresh oil	

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE and DIESEL ENGINES	Dec. 2012

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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			
				A1 / B1-12	**A3 / B3-12**	**A3 / B4-12**	**A5 / B5-12**
2. ENGINE TESTS							
2.1 High temperature deposits Ring sticking Oil thickening	CEC L-088-02 (TU5JP-L4) 72 Hour test	Ring sticking (each part) Piston varnish (5 elements, average of 4 pistons) Absolute viscosity increase at 40°C between min and max values during test Oil consumption	Merit Merit mm^2/s kg/test	≥ 9.0 ≥ RL 216 ≤ 0.8 x RL216 Report			
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	CEC L-038-94 (TU3M)	Cam wear, average Cam wear, max. Pad merit (Ave. of 8 pads)	µm µm merit	≤ 10 ≤ 15 ≥ 7.5			
2.4 * Black sludge		Engine sludge, average	merit	≥ RL 140 + 4σ			
2.5 * Fuel economy	CEC L-054-96 (M111)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 2.5	--		≥ 2.5
2.6 Medium temperature dispersivity	CEC L-093-04 (DV4TD) **To be replaced by DV6C**	Absolute viscosity increase at 100°C and 6 % soot Piston merit	mm2/s merit	≤ 0.60 x RL223 result ≥ (RL223 –2,5pts)			
2.7 * Oil Dispersion at Medium Temperature for Passenger Car Direct Injection Diesel Engines	CEC L-106 (DV6C)	Absolute viscosity increase at 100°C and 6 % soot Piston merit	mm2/s merit	limits to defined			
2.8 * Wear	CEC L–099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams) Cam wear inlet (avg. max. wear 8 c.) Cylinder wear (avg. 4 cyl.) Bore polishing (13 mm) - max. value of 4 cylinders Tappet wear inlet (avg. max. wear 8 cams) Tappet wear outlet (avg. max. wear 8cams) Piston cleanliness (avg. 4 pistons) Engine sludge avg.	µm µm µm % µm µm merits merits	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report report report	≤ 140 ≤ 110 ≤ 5.0 ≤ 3.5 report report report report	≤ 120 ≤ 100 ≤ 5.0 ≤ 3.0 report report ≥ 12 ≥ 8,8	

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				A1 / B1-12	**A3 / B3-12**	**A3 / B4-12**	**A5 / B5-12**
2. ENGINE TESTS CONTINUED							
2.9 * DI diesel Piston cleanliness & Ring sticking	CEC L-078-99 (VW TDI)	Piston cleanliness	merit	≥ RL206	≥ RL206 minus 4 points	≥ RL206	≥ RL206
		Ring sticking (Rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771)	mgKOH/g	≥ 4.0	≥ 4.0	≥ 6.0	≥ 4.0
		EOT TAN (ASTM D 664)	mgKOH/g	Report	Report	Report	Report
2.10 * Effects of Biodiesel	CEC L-104	Piston Cleanliness	Merits			Report	
		Ring Sticking	ASF			Report	
		Sludge	Merits			Report	

*: Additional information is given as footnotes underneath the table for the C-categories, page 12.

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE and DIESEL ENGINES WITH AFTER TREATMENT DEVICES	Dec. 2012

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			
				C1-12	**C2-12**	**C3-12**	**C4-12**
1. 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	100°C Viscosity after 30 cycles	mm^2/s	All grades to be stay in grade			
1.3 Viscosity at high temp. & high shear rate	CEC L-036-90	Viscosity at 150°C and 10^6 s^{-1} shear rate	mPa.s	≥ 2.9		≥ 3.5	
1.4 Evaporative loss	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 13			≤ 11
1.5 TBN	ASTM D 2896		mg KOH / g			≥ 6.0	
1.6 * Sulphur	ASTM D5185		% m/m	≤ 0.2	≤ 0.3		≤ 0.2
1.7 * Phosphorus	ASTM D5185		% m/m	≤ 0.05	≤ 0.090	≥ 0.070 ≤0.090	≤ 0.090
1.8 * Sulphated ash	ASTM D874		**% m/m**	≤ 0.5	≤ 0.8		≤ 0.5
1.9 Chlorine	ASTM D6443		ppm m/m	Report			
1.10 * Oil / elastomer compatibility	CEC L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type			
				RE1	RE2-99	RE3-04	RE4	DBL-AEM
		Hardness DIDC	points	-1/+5	-5/+8	-22/ +1	-5/+5	-5/+10
		Tensile strength	%	-40/+10	-15/+18	-30/+10	-20/+10	-35/ -
		Elongation at rupture	%	-50/+10	-35/+10	-20/+10	-50/+10	-50/ -
		Volume variation	%	-1/+5	-7/+5	-1/+22	-5/+5	-5/+15
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 * Oxidation in presence of biodiesel	GFC-Lu-43A-11	Catalysed ageing test until 144h at 170°C & with air bubbling: 1. on pure oil 2. with B10 added (B71 1892 GO B10 LUB)		Report			
		PAI at 144h	%				
		Kin. viscosity @ 100°C variation: at 72h	cSt & %	Report			
		at 96h	cSt & %	Report			
		at 120h	cSt & %	Report			
		at 144h	cSt & %	Report and at 144h: < +200% (no solidification)			
1.14 Low-Temperature Pumpability	CEC L-105	MRV Yield stress (MRV at SAE J300 temperatures applicable for the fresh oil viscosity grade)	mPas Pa	Acc to SAE J300 for fresh oil			

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				C1-12	**C2-12**	**C3-12**	**C4-12**
2. ENGINE TESTS							
2.1 High temperature deposits Ring sticking Oil thickening	CEC L-088-T-02 (TU5JP-L4) 72 Hour test	Ring sticking (each part) Piston varnish (5 elements, average of 4 pistons) Absolute viscosity increase at 40°C between min and max values during test Oil consumption	Merit Merit mm^2/s kg/test	≥ 9.0 ≥ RL 216 ≤ 0.8 x RL216 Report			
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	CEC L-038-94 (TU3M)	Cam wear, average Cam wear, max. Pad merit (Ave. of 8 pads)	µm µm merit	≤ 10 ≤ 15 ≥ 7.5			
2.4 * Black sludge		Engine sludge, average	merit	≥ RL 140 + 4σ			
2.5 * Fuel economy	CEC L-54-96 (M111)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 3.0	≥ 2.5	≥ 1.0 (for Xw30 grades)	
2.6 Medium temperature dispersivity	CEC L-093-04 (DV4TD) **To be replaced by DV6**	Absolute viscosity increase at 100°C and 6 % soot Piston merit	mm²/s merit	≤ 0.60 x RL223 result ≥ (RL223 –2,5pts)			
2.7 * Oil Dispersion at Medium Temperature for Passenger Car Direct Injection Diesel Engines	CEC L-106 (DV6C)	Absolute viscosity increase at 100°C and 6 % soot Piston merit	mm²/s merit	limits to defined			

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE and DIESEL ENGINES WITH AFTER TREATMENT DEVICES	Dec. 2012

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				C1-12	**C2-12**	**C3-12**	**C4-12**
2. ENGINE TESTS CONTINUED							
2.8 * Wear	CEC L-099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 120	≤ 120	≤ 120	
		Cam wear inlet (avg. max. wear 8 c.)	µm	≤ 100	report	≤ 100	
		Cylinder wear (avg. 4 cyl.)	µm	≤ 5.0	≤ 5.0	≤ 5.0	
		Bore polishing (13 mm) - max. value of 4 cylinders	%	≤ 3.0	≤ 3.0	≤ 3.0	
		Tappet wear inlet (avg. max. wear 8cams)	µm	report	report	report	
		Tappet wear outlet (avg. max. wear 8cams)	µm	report	report	report	
		Piston cleanliness (avg. 4 pistons)	merits	report	report	≥ 12	
		Engine sludge avg.	merits	report	report	≥ 8,8	
2.9 * DI diesel Piston cleanliness & Ring sticking	CEC L-078-99 (VW TDI)	Piston cleanliness	merit	≥ RL206	≥ RL206	≥ RL206	
		Ring sticking (Rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	
		Max. for any 1st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	
		Max. for any 2nd ring	ASF	0.0	0.0	0.0	
		EOT TBN (ISO 3771)	mgKOH/g	report	report	report	
		EOT TAN (ASTM D 664)		report	report	report	
2.10 * Effects of Biodiesel	CEC L-104	Piston Cleanliness	Merits	Report			
		Ring Sticking	ASF	Report			
		Sludge	Merits	Report			

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

No. 1.2 The minimum viscosity for xW-20 oils after shearing is 5,6 cSt.

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 has to be used.

No. 1.10 All reference materials and limits for RE1, RE2, RE3, RE4 and DBL-AEM can be used until acceptable new reference materials (proposed from CEC L-039-96) are available and appropriate limits have been set. The Daimler requirements for DBL-AEM D 8948/200 are VDA 675301, 7 days ± 2h, 150°C ± 2°C, closed cup test.
RE-1, RE-2, RE-3, RE-4 based on CEC and DBL-AEM based on Daimler AG data may continue to be used "grandfathered" for the lifetime of the ACEA 2012 sequences.

No. 1.13 Until a CEC Test Method is developed, the oxidation behavior of engine oil formulations must be proved by GFC-Lu-43A-11. Test results obtained by this procedure will be accepted under the condition that they come from labs having participated to the official round robin and comply with the quality criteria of GFC.

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.

No. 2.4 Until a new CEC Test Method is developed, the gasoline sludge protection performance of engine oil formulations must be proved by the M 271 sludge test procedure as described by Daimler AG. Test results obtained by the M 271 procedure will be accepted 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.

No. 2.5 ACEA considers the CEC L-54-T-96 test the only valid comparator against which claims of lubricant fuel economy improvement should be made.

No. 2.7 May be performed as soon as it becomes available as an alternative to the DV4 test. ACEA will decide when the DV4 test will be finally deleted from this specification. CEC-L-093-04 (DV4 Test) test results obtained in accordance with the ATIEL guidelines may be used by a grandfathering process also after this test has become unavailable to run and is replaced by the CEC-L-106 (DV6 Test) procedure.

No. 2.8 Not all parameters are yet official CEC parameters. C2 limit for inlet cam wear under definition.

No. 2.9 Test report has to give measured values before & after the test, all measurements to be taken in the same lab. Note: TAN is considered to become performance criteria in the future. Not all parameters are yet official CEC parameters.

No. 2.10 Test is still under development at the time of publishing of this specification. Test has to be performed for all qualifications against 2012 Oil Sequences from the time the test is officially released by CEC (running programs only). All test criteria is rate and report.

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR HEAVY DUTY DIESEL ENGINES	Dec. 2012

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.

REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-12	**E6-12**	**E7-12**	**E9-12**
1. LABORATORY TESTS							
1.1 Viscosity		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	Viscosity after 30 cycles measured at 100°C.	mm^2/s	Stay in grade			
	ASTM D6278	Viscosity after 90 cycles measured at 100°C	mm^2/s		Stay in grade		
1.3 Viscosity High Temperature High Shear Rate	CEC L-036-90	Viscosity at 150°C and 10^6 s^{-1} Shear rate	mPa.s	≥ 3.5			
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-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		RE1	Elastomer type RE2-99	RE3-04	RE4	DBL-AEM
		Hardness DIDC	points	-1/+5	-5/+8	-25/+1	-5/+5	-5/+10
		Tensile strength	%	-50/+10	-15/+18	-45/+10	-20/+10	-35/ -
		Elongation rupture	%	-60/+10	-35/+10	-20/+10	-50/+10	-50/ -
		Volume variation	%	-1/+5	-7/+5	-1/+30	-5/+5	-5/+15
1.9 Foaming Tendency	ASTM D892 without option A	Tendency – stability	ml ml 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	Tendency - stability	ml	Sequence IV (150°C) 200-50				
1.11 Oxidation	CEC L-085-99 (PDSC)	Oxidation induction time	min	R&R		≥ 65		
1.12 Corrosion	ASTM D 6594	Copper increase Lead increase Copper strip rating	ppm ppm max	R&R R&R R&R		R&R ≤ 100 R&R		≤ 20 ≤ 100 3
1.13 * TBN	ASTM D2896		mg KOH/g	≥12	≥ 7	≥ 9		≥7
1.14 Low temperature pumpability	CEC L-105	MRV Yield stress (MRV at SAE J300 temperatures applicable for the fresh oil viscosity grade)	mPas Pa	Acc to SAE J300 for fresh oil				

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR HEAVY DUTY DIESEL ENGINES	Dec. 2012

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.

REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-12	**E6-12**	**E7-12**	**E9-12**
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	
2.3 Soot in oil	Mack T11	Min TGA soot @ 4.0 cSt (100°C) Min TGA soot @ 12.0 cSt (100°C) Min TGA soot @ 15.0 cSt (100°C)	%				3.5/3.4/3.3 6.0/5.9/5.9 6.7/6.6/6.5
2.4 * Bore polishing **Piston Cleanliness**	CEC L-101-08 (OM501LA)	Bore polishing, average Piston Cleanliness, average Oil consumption Engine sludge, average	% merit kg/test Merit	≤ 1.0 ≥ 26 ≤ 9 R&R	≤ 1.0 ≥ 26 ≤ 9 R&R	≤ 2.0 ≥ 17 ≤ 9 R&R	≤ 2.0 ≥ 17 ≤ 9 R&R
2.5 * Soot induced wear	Cummins ISM	Merit Rocker pad average weight loss at 3.9 % soot 1 test/2 test/3 test average Oil filter diff.press @ 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	≥1000 ≤ 7.1 ≤ 19 ≥ 8.7 ≤ 49
2.6 * Wear (liner-ring-bearings)	Mack T12	Merit Avg.liner wear Average top ring weight loss 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

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

No. 1.6;1.7 Internal standard method has to be used.

No. 1.8 All reference materials and limits for RE1, RE2, RE3, RE4 and DBL-AEM can be used until acceptable new reference materials (proposed from CEC L-039-96) are available and appropriate limits have been set. The Daimler requirements for DBL-AEM D 8948/200 are VDA 675301, 7 days ± 2h, 150°C ± 2°C, closed cup test.
RE-1, RE-2, RE-3, RE-4 based on CEC and DBL-AEM based on Daimler AG data may continue to be used "grandfathered" for the lifetime of the ACEA 2012 sequences.

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

No. 2.1 OM602A data can be used instead of OM646LA data providing it meets the requirements as specified in the 2007 ACEA sequences.
Additional parameters may be included once approved by CEC.

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

No. 2.4 Bore polish, oil consumption and engine sludge are non-approved CEC parameters.
OM441LA data can be used instead of OM501LA data providing it meets the requirements as specified in the 2007 ACEA sequences.

No. 2.5 For E7 results from M11HST (ASTM D6838), at API CH-4, or M11EGR (ASTM D6975), at API CI-4 or CI-4 Plus, can be used in place of Cummins ISM. Merit number shall be calculated according to the API CI-4 specification

No. 2.6 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.