



**A C E A**  
**European**  
**Automobile**  
**Manufacturers**  
**Association**

# **ACEA EUROPEAN OIL SEQUENCES**

## **2010**

### **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 2010 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 2008 sequences as a means of defining engine lubricant quality from 22<sup>nd</sup> December 2010.

### 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<sup>1</sup>, 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 2010 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](http://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	1 <sup>st</sup> November 2004	1 <sup>st</sup> November 2005	31 <sup>st</sup> December 2009
2007	1 <sup>st</sup> February 2007	1 <sup>st</sup> February 2008	23 <sup>rd</sup> December 2010
2008	22 <sup>nd</sup> December 2008	22 <sup>nd</sup> December 2009	22 <sup>nd</sup> December 2012
2010	22 <sup>nd</sup> December 2010	22 <sup>nd</sup> December 2011	...

**Table:** For the 2010 issue of the ACEA Oil Sequences: First claims can be made from 22<sup>nd</sup> December 2010. For another year (until 22<sup>nd</sup> December 2011), oil marketers can still make new claims against ACEA 2008. Starting with 22<sup>nd</sup> December 2011 every new claim has to be made against the 2010 ACEA Oil Sequences. All engine oils using claims against the 2008 ACEA Sequences can be continued to be marketed until 22<sup>nd</sup> December 2012.

- 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).

<sup>1</sup> 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 a form which is available in the appropriate section of the ACEA website ([www.acea.be](http://www.acea.be)).

Engine Oils claiming any of the ACEA oil sequences should be registered directly after their launch into the market. After completing the form it 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 needed.

### REPLACEMENT of CCMC sequences

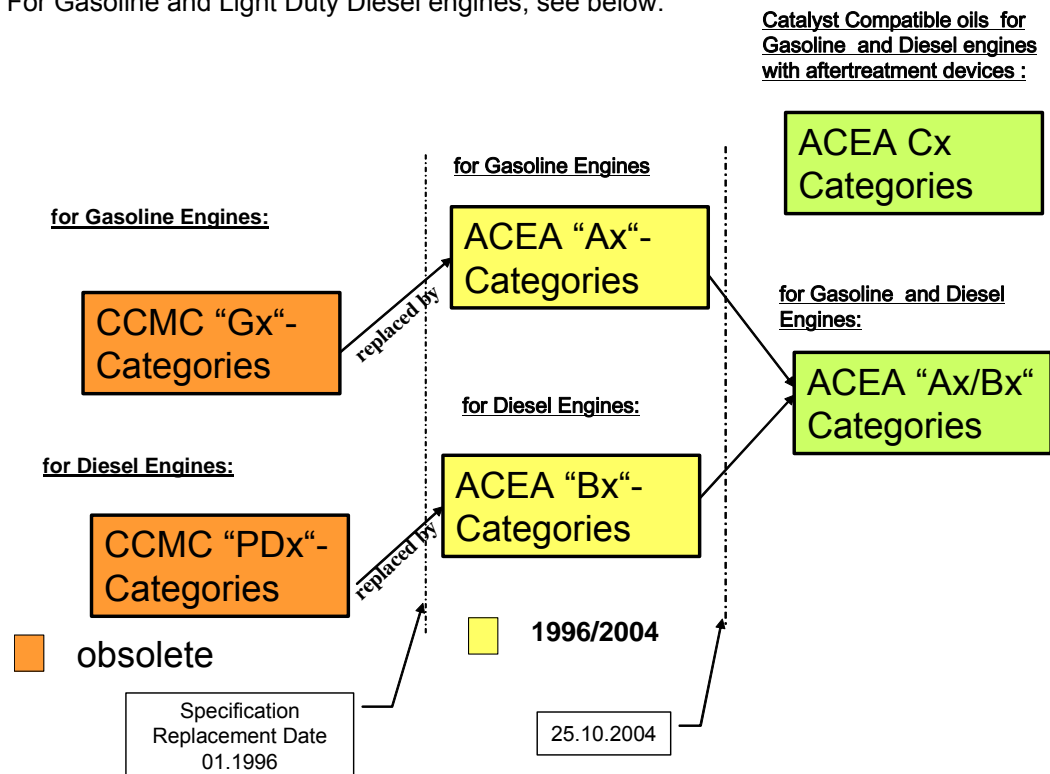
The chart below shows the evolution of the engine oil specifications commonly developed by the European Automobile manufacturers. CCMC (Comité des Constructeurs du Marché Commun) was the forerunner organisation to ACEA.

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

The ACEA 2010 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 NO<sub>x</sub> 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 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 EGR engines, with or without particulate filters, and for engines fitted with SCR NO<sub>x</sub> 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 NO<sub>x</sub> 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 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 with or without particulate filters, and for most EGR engines and for most engines fitted with SCR NO<sub>x</sub> 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

<b>ACEA</b>	<b>ACEA 2010 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE and DIESEL ENGINES</b>	<b>Dec. 2010</b>
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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				
				A1 / B1-10	A3 / B3-10	A3 / B4-10	A5 / B5-10	
<b>1. LABORATORY TESTS</b>								
<b>1.1 Viscosity grades</b>		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.				
<b>1.2 Shear stability</b>	CEC L -014-93 or ASTM D6278	100°C Viscosity after 30 cycles	mm <sup>2</sup> /s	xW-20 stay in grade xW-30 ≥ 9.3 xW-40 ≥ 12.0	All grades to be stay in grade			
<b>1.3 Viscosity at high temp. &amp; high shear rate</b>	CEC L-036-90	Viscosity at 150°C and 10 <sup>6</sup> s <sup>-1</sup> shear rate	mPa.s	≥ 2.9 and ≤ 3.5; xW-20: 2.6. min	≥ 3.5		≥ 2.9 and ≤ 3.5	
<b>1.4 Evaporative loss</b>	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 15	≤ 13			
<b>1.5 TBN</b>	ASTM D 2896		mgKOH/g	≥ 8.0	≥ 8.0	≥ 10.0	≥ 8.0	
<b>1.6 Sulphated ash</b>	ASTM D874		% m/m	≤ 1.3 (see note 2)	≥ 0,9 and ≤ 1.5 (see note 2)	≥ 1,0 and ≤ 1.6 (see note 2)	≤ 1.6 (see note 2)	
<b>1.7 Sulphur</b> (see note 1)	ASTM D5185		% m/m	Report				
<b>1.8 Phosphorus</b> (see note 1)	ASTM D5185		% m/m	Report				
<b>1.9 Chlorine</b>	ASTM D6443		ppm m/m	Report				
<b>1.10 Oil / elastomer compatibility</b>	CEC L-039-96 (see note 3)	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing Hardness DIDC Tensile strength Elongation at rupture Volume variation	points % % %		Elastomer	type	:	:
				RE1	RE2-99	RE3-04	RE4	AEM
				-1/+5	-5/+8	-22/+1	-5/+5	(VAMAC
				-40/+10	-15/+18	-30/+10	-20/+10	)
				-50/+10	-35/+10	-20/+10	-50/+10	As per
-1/+5	-7/+5	-1/+22	-5/+5	Daimler				
<b>1.11 Foaming tendency</b>	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				
<b>1.12 High temperature foaming tendency</b>	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150°C) 100 - nil				

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				A1 / B1-10	A3 / B3-10	A3 / B4-10	A5 / B5-10
<b>2. ENGINE TESTS</b>							
<b>2.1</b> <b>High</b> <b>temperature</b> <b>deposits</b> <b>Ring sticking</b> <b>Oil thickening</b>	CEC L-088-02 (TU5JP-L4)  72 Hour test	Ring sticking (each part)	Merit	≥ 9.0			
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216			
		Absolute viscosity increase at 40°C between min and max values during test	mm <sup>2</sup> /s	≤ 0.8 x RL216			
		Oil consumption	kg/test	Report			
<b>2.2</b> <b>Low</b> <b>temperature</b> <b>sludge</b>	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API (See Note 4)	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					
<b>2.3</b> <b>Valve train</b> <b>scuffing wear</b>	CEC L-038-94 (TU3M)	Cam wear, average	µm	≤ 10			
		Cam wear, max.	µm	≤ 15			
		Pad merit (Ave. of 8 pads)	merit	≥ 7.5			
<b>2.4</b> <b>Black sludge</b>	(10, 11)	Engine sludge, average	merit	≥ RL 140 + 4σ			
<b>2.5</b> <b>Fuel economy</b> See Note (5)	CEC L-054-96 (M111)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 2.5	—	≥ 2.5	
<b>2.6</b> <b>Medium</b> <b>temperature</b> <b>dispersivity</b>	CEC L-093-04 (DV4TD)	Absolute viscosity increase at 100°C and 6 % soot	mm <sup>2</sup> /s	≤ 0.60 x RL223 result			
		Piston merit	merit	≥ (RL223 -2,5pts ) ≤ 0.60 x RL223 result			
<b>2.7</b> <b>Wear</b> See notes (6)	CEC L-099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 140		≤ 120	
		Cam wear inlet (avg. max. wear 8 c.); (8)	µm	≤ 110		≤ 100	
		Cylinder wear (avg. 4 cyl.); s. note (8)	µm	≤ 5.0		≤ 5.0	
		Bore polishing (13 mm) - max. value of 4 cylinders; s. note (8)	%	≤ 3.5		≤ 3.0	
		Tappet wear inlet (avg. max. wear 8 cams)	µm	report		report	
		Tappet wear outlet (avg. max. wear 8cams)	µm	report		report	
		Piston cleanliness (avg. 4 pistons)	merits	report		report	
		Engine sludge avg.	merits	report		report	



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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				A1 / B1-10	A3 / B3-10	A3 / B4-10	A5 / B5-10
<b>2. ENGINE TESTS CONTINUED</b>							
<b>2.8</b> <b>DI diesel</b> <b>Piston</b> <b>cleanliness &amp;</b> <b>Ring sticking</b> See notes (9)	CEC L-078-99 (VW TDI)	Piston cleanliness	merit	≥ RL206 minus 4 points	≥ RL206 minus 4 points	≥ RL206	≥ RL206
		Ring sticking (Rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.2	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 <sup>st</sup> ring	ASF	≤ 2.5	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 <sup>nd</sup> ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771); s. note (7 & 8)	mgKOH /g	≥ 4.0	≥ 4.0	≥ 6.0	≥ 4.0
EOT TAN (ASTM D 664); s. note (7)	mgKOH /g	Report	Report	Report	Report		

- (1) The internal standard method has to be used.
- (2) Maximum limits, Values take into account method and production's tolerances
- (3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2h, 4 materials (NBR: NBR34 DIN 53538 T3 (100 °C +/- 2°C); FPM: AK6 (150 °C +/- 2°C); ACM: E7503 (150 °C +/- 2°C); AEM: D 8948/200.1 (150 °C +/- 2°C)) + RE3, or complete requirements according to 1.10 above + Daimler requirements for AEM
- (4) The limits shown are based upon 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.
- (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.
- (6) For A1/B1 claims OM 602A passing results obtained before the end of 2008 can be used instead of OM 646LA results.
- (7) 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 a future performance criteria.
- (8) These parameters are not yet official CEC parameters.
- (9) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without passing the EOT TBN criteria and reporting EOT TAN values.
- (10) Until a new CEC Test Method is developed, the gasoline sludge protection performance of engine oil formulations must be proofed 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.
- (11) Existing results from tests with CEC-L-053 may be used where applicable. In this case limits for all ACEA A/B categories (including A1/B1) are:  
≥ RL 140 + 4σ or ≥ 9.0

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				C1-10	C2-10	C3-10	C4-10	
<b>1. LABORATORY TESTS</b>								
<b>1.1 Viscosity grades</b>		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.				
<b>1.2 Shear stability</b>	CEC L-014-93 or ASTM D6278	100°C Viscosity after 30 cycles	mm <sup>2</sup> /s	All grades to be stay in grade				
<b>1.3 Viscosity at high temp. &amp; high shear rate</b>	CEC L-036-90	Viscosity at 150°C and 10 <sup>6</sup> s <sup>-1</sup> shear rate	mPa.s	≥ 2.9		≥ 3.5		
<b>1.4 Evaporative loss</b>	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 13			≤ 11	
<b>1.5 TBN</b>	ASTM D 2896		mg KOH / g				≥ 6.0	
<b>1.6 Sulphur</b>	ASTM D5185	(see note 1)	% m/m	≤ 0.2	≤ 0.3		≤ 0.2	
<b>1.7 Phosphorus</b>	ASTM D5185	(see note 1)	% m/m	≤ 0.05 (2)	≤ 0.090 (2)	≥ 0.070 ≤ 0.090 (2)	≤ 0.090 (2)	
<b>1.8 Sulphated ash</b>	ASTM D874		% m/m	≤ 0.5 (2)	≤ 0.8 (2)		≤ 0.5 (2)	
<b>1.9 Chlorine</b>	ASTM D6443		ppm m/m	Report				
<b>1.10 Oil / elastomer compatibility</b>	CEC L-039-96  (see note 3)	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing Hardness DIDC Tensile strength Elongation at rupture Volume variation	Elastomer type					
				RE1	RE2-99	RE3-04	RE4	AEM VAMAC
			points	-1/+5	-5/+8	-22/ +1	-5/+5	As per Daimler
			%	-40/+10	-15/+18	-30/+10	-20/+10	
			%	-50/+10	-35/+10	-20/+10	-50/+10	
%	-1/+5	-7/+5	-1/+22	-5/+5				
<b>1.11 Foaming tendency</b>	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				
<b>1.12 High temperature foaming tendency</b>	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150°C) 100 - nil				

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			
				C1-10	C2-10	C3-10	C4-10
<b>2. ENGINE TESTS</b>							
<b>2.1 High temperature deposits</b> <b>Ring sticking</b> <b>Oil thickening</b>	CEC L-088-T-02 (TU5JP-L4)  72 Hour test	Ring sticking (each part)	Merit	≥ 9.0			
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216			
		Absolute viscosity increase at 40°C between min and max values during test	mm <sup>2</sup> /s	≤ 0.8 x RL216			
		Oil consumption	kg/test	Report			
<b>2.2 Low temperature sludge</b>	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API (See Note 4)	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			
<b>2.3 Valve train scuffing wear</b>	CEC L-038-94 (TU3M)	Cam wear, average	µm	≤ 10			
		Cam wear, max.	µm	≤ 15			
		Pad merit (Ave. of 8 pads)	merit	≥ 7.5			
<b>2.4 Black sludge</b>	(11, 12)	Engine sludge, average	merit	≥ RL 140 + 4σ			
<b>2.5 Fuel economy</b> See Note (5)	CEC L-54-96 (M111)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 3.0	≥ 2.5	≥ 1.0 (for Xw30 grades)	
<b>2.6 Medium temperature dispersivity</b>	CEC L-093-04 (DV4TD)	Absolute viscosity increase at 100°C and 6 % soot	s	≤ 0.60 x RL223 result			
		Piston merit	merit	≥ (RL223 -2,5pts )			
<b>2.7 Wear</b> See notes (6)	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.); (9)	µm	≤ 100	report, note(8)	≤ 100	
		Cylinder wear (avg. 4 cyl.); s. note (9)	µm	≤ 5.0	≤ 5.0	≤ 5.0	
		Bore polishing (13 mm) - max. value of 4 cylinders; s. note (9)	%	≤ 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	report	
		Engine sludge avg.	merits	report	report	report	

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				C1-10	C2-10	C3-10	C4-10
<b>2. ENGINE TESTS CONTINUED</b>							
<b>2.8 DI diesel Piston cleanliness &amp; Ring sticking</b> See notes (10)	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 1 <sup>st</sup> ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	
		Max. for any 2 <sup>nd</sup> ring	ASF	0.0	0.0	0.0	
EOT TBN (ISO 3771) and EOT TAN (ASTM D 664); s. note (7)	mgKOH /g	report	report	report			

- (1) The internal standard method has to be used.
- (2) Maximum limits, Values take into account method and production's tolerances
- (3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2h, 4 materials (NBR: NBR34 DIN 53538 T3 (100 °C +/- 2°C); FPM: AK6 (150 °C +/- 2°C); ACM: E7503 (150 °C +/- 2°C); AEM: D 8948/200.1 (150 °C +/- 2°C)) + RE3, or complete requirements according to 1.10 above + Daimler requirements for AEM
- (4) The limits shown are based upon 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.
- (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.
- (6) Limits for C1 might be revised if needed. For C1 claims OM 602A passing results obtained before the end of 2008 can be used instead of OM 646LA results.
- (7) Test report has to give measured values before & after the test, all measurements to be taken in the same lab.
- (8) Limit under definition.
- (9) These parameters are not yet official CEC parameters.
- (10) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without reporting EOT TBN & TAN.
- (11) Until a new CEC Test Method is developed, the gasoline sludge protection performance of engine oil formulations must be proofed 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.
- (12) Existing results from tests with CEC-L-053 may be used where applicable. In this case limits for all ACEA C categories are:  
≥ RL 140 + 4σ or ≥ 9.0

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REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				E4-08 Issue 2	E6-08 Issue 2	E7-08 Issue 2	E9-08 Issue 2	
<b>1. LABORATORY TESTS</b>								
<b>1.1 Viscosity</b>		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.				
<b>1.2 Shear stability</b>	CEC L-014-93 or ASTM D6278	Viscosity after 30 cycles measured at 100°C.	mm <sup>2</sup> /s	Stay in grade				
	ASTM D6278	Viscosity after 90 cycles measured at 100°C	mm <sup>2</sup> /s		Stay in grade			
<b>1.3 Viscosity High Temperature High Shear Rate</b>	CEC L-036-90	Viscosity at 150°C and 10 <sup>6</sup> s <sup>-1</sup> Shear rate	mPa.s	≥ 3.5				
<b>1.4 Evaporative Loss</b>	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 13				
<b>1.5 Sulphated Ash</b>	ASTM D874		% m/m	≤ 2.0	≤ 1.0	≤ 2.0	≤ 1.0	
<b>1.6 Phosphorus</b> (Note 1)	ASTM D5185 <sup>+</sup>		% m/m		≤ 0.08		≤ 0.12	
<b>1.7 Sulphur</b> (Note 1)	ASTM D5185 <sup>+</sup>		% m/m		≤ 0.3		≤ 0.4	
<b>1.8 Oil Elastomer Compatibility</b> (Note 2)	CEC L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		RE1	Elastomer RE2-99	type RE3-04	RE4	AEM (VAMAC)
		Hardness DIDC	points	-1/+5	-5/+8	-25/+1	-5/+5	As per Daimler
		Tensile strength	%	-50/+10	-15/+18	-45/+10	-20/+10	
		Elongation rupture	%	-60/+10	-35/+10	-20/+10	-50/+10	
Volume variation	%	-1/+5	-7/+5	-1/+30	-5/+5			
<b>1.9 Foaming Tendency</b>	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
<b>1.10 High temperature foaming tendency</b>	ASTM D6082	Tendency - stability	ml	Sequence IV (150°C) 200-50				
<b>1.11 Oxidation</b>	CEC L-085-99 (PDSC)	Oxidation induction time	min	R&R			≥ 65	
<b>1.12 Corrosion</b>	ASTM D 6594	Copper increase	ppm	R&R			R&R	≤ 20
		Lead increase	ppm	R&R			≤ 100	≤ 100
		Copper strip rating	max	R&R			R&R	3
<b>1.13 Turbocharger performance</b> (Note 3)								
<b>1.14 TBN</b>	ASTM D2896		mg KOH/g	≥ 12	≥ 7	≥ 9 (Note 4)	≥ 7	

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REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-08 Issue 2	E6-08 Issue 2	E7-08 Issue 2	E9-08 Issue 2
<b>2. ENGINE TESTS</b>							
<b>2.1 Wear</b>	CEC L-099-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 140 (Notes 5, 6)	≤ 140 (Notes 5, 6)	≤ 155 (Notes 5, 6)	≤ 155 (Notes 5, 6)
<b>2.2 Soot in oil</b> (Note 7)	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	
<b>2.3 Soot in oil</b>	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
<b>2.4 Bore polishing</b> <b>Piston Cleanliness</b>	CEC L-101-08 (OM501LA)	Bore polishing, average Piston Cleanliness, average Oil consumption Engine sludge, average (Note 8)	% merit kg/test Merit	≤ 1.0 ≥ 26 ≤ 9 R&R (Notes 9,10)	≤ 1.0 ≥ 26 ≤ 9 R&R (Notes 9,10)	≤ 2.0 ≥ 17 ≤ 9 R&R (Notes 9,10)	≤ 2.0 ≥ 17 ≤ 9 R&R (Notes 9,10)
<b>2.5. Soot induced wear</b>	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 (Note 11)	≥1000 ≤ 7.1 ≤ 19 ≥ 8.7 ≤ 49
<b>2.6. Wear (liner- ring-bearings)</b>	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 (Notes 12, 13)	≥ 1000 ≤ 26 ≤ 117 ≤ 42 ≤ 18 ≤ 95 (Notes 12, 13)	≥ 1000 ≤ 24 ≤ 105 ≤ 35 ≤ 15 ≤ 85

- (1) The internal standard method has to be used.
- (2) Use either the most recent complete Daimler requirements (VDA 675301, 7 days, 4 materials (NBR: NBR34 DIN 53538 T3 (100 °C); FPM: AK6 (150 °C); ACM: E7503 (150 °C); AEM: D 8948/200.1 (150 °C)) + RE3 according to requirement 1.8 above, or complete requirements according to 1.8 above + Daimler requirements for AEM.
- (3) Should a test become available before the next document update, ACEA reserves the right to set performance limits providing adequate data is available.
- (4) Values < 9.00 are not accepted.
- (5) OM602A data can be used instead of OM646LA data providing it meets the requirements as specified in the 2007 ACEA sequences.
- (6) Additional parameters may be included once approved by CEC.
- (7) 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.
- (8) Bore polish, oil consumption and engine sludge are non-approved CEC parameters.
- (9) OM441LA data can be used instead of OM501LA data providing it meets the requirements as specified in the 2007 ACEA sequences.
- (10) Limits for the sludge parameter may be reconsidered when more data becomes available.
- (11) 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.
- (12) Merit number shall be calculated according to the API CI-4 specification
- (13) 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.