ACEA EUROPEAN OIL SEQUENCES

2021 Service Fill Engine Oils for Gasoline and Light Duty Diesel Engines (A/B Categories), Gasoline and Light Duty Diesel Engines with Exhaust Aftertreatment Devices (C Categories)
2022 Service Fill Engine Oils for Heavy Duty Engines (E Categories)

Lubrizol

ACEA European Oil Sequences Update

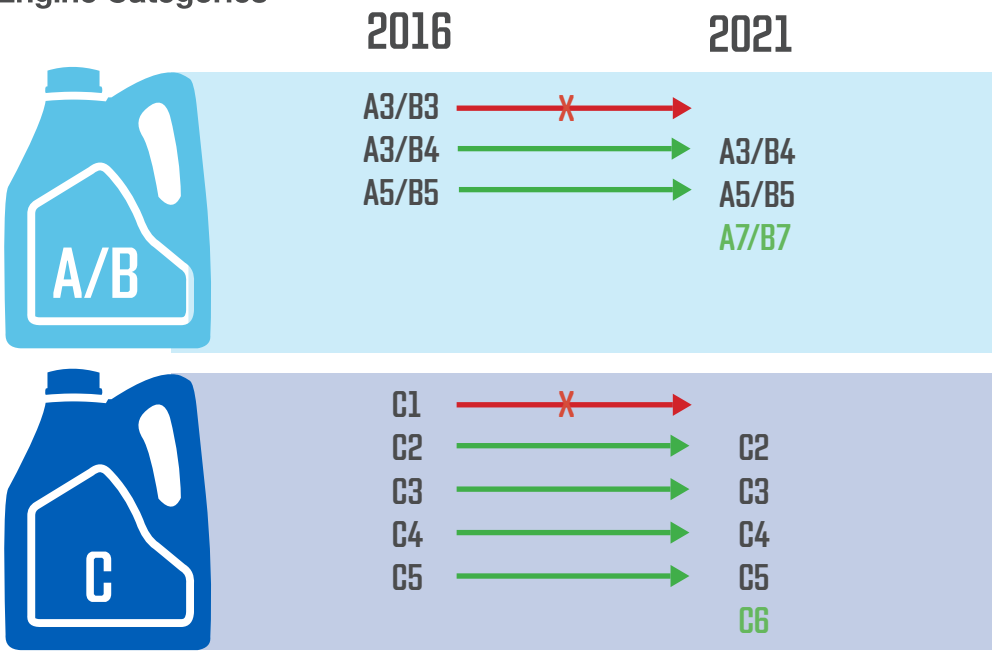
For the first time in the ACEA European Oil Sequences history the Light Duty and Heavy Duty Oil Sequences were updated separately and with individual documents. This move by ACEA is illustrative of the continually shifting challenges faced by Original Equipment Manufacturers (OEMs) and by oil marketers along with the need for flexibility in maintaining specifications which align to hardware and regulatory advances.

This document has been created as a point of reference for increasing awareness and understanding of the ACEA European Oil Sequences following the most recent updates. Within this document you will find the latest Light Duty Oil Sequences, effective 1st May 2021, and Heavy Duty Oil Sequences, effective 1st May 2022.

The information contained in this document is based on the official documents created and released by ACEA, which can be viewed on www.acea.be. It is advisable to refer to the ACEA website for the latest version of the official ACEA Oil Sequences document.

Category Changes At A Glance

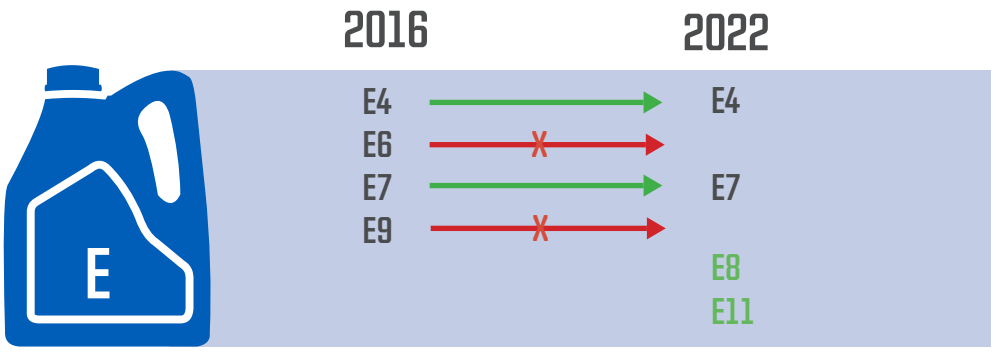
Light Duty Engine Categories



The 2021 update sees the removal of category ACEA A3/B3 from the high Sulphated Ash, Phosphorous and Sulphur (SAPS) gasoline and diesel engine lubricant sequences, and the addition of the new ACEA A7/B7 category which builds on the performance and test requirements of ACEA A5/B5. Within the lower SAPS sequences for Gasoline Particulate Filter (GPF)/Diesel Particulate Filter (DPF) compatible engine lubricants we see the removal of ACEA C1 category and introduction of the ACEA C6 category, which builds on the performance and test requirements of ACEA C5.

Heavy Duty Engine Categories

The 2022 update sees the removal of ACEA E6 and E9 from the lower SAPS sequences. In their place ACEA E8 and E11 have been introduced respectively, representing a significant performance upgrade. ACEA E4 and E7 categories remain in the ACEA 2022 sequences to serve legacy engines. Changes to test methods and requirements are intended to increase performance in some areas and to ensure key parameters continue to be measured in others, as original test hardware reaches the end of its lifecycle.



Introduction to Changes

The latest documents released by ACEA include multiple updates relating to test methods, categories, limits and presentation of the data. There are some key aspects and themes, echoing the trends seen in the vehicle parc and those predicted for the future.

1. Creation of the new ACEA European Oil Sequences General Requirements document
2. Release of the ACEA European Oil Sequences for Light Duty and Heavy Duty Engines as stand-alone documents
3. Updates to improve piston cleanliness
4. Removal of tests for older technologies

Light Duty Engine Sequence Updates

The light duty oil sequences update impacts both the ACEA A/B category for high SAPS and the ACEA C categories for lower SAPS.

For high SAPS we see the removal of the ACEA A3/B3 category and the introduction of ACEA A7/B7.
Eight key new performance tests are introduced:

> *CEC L-107-19 M271 Evo Sludge (replaces M271 Classic Sludge) (all categories)*
> *CEC L-114-19 Toyota Turbocharger Compressor Deposit Test 1KD-FTV (ACEA A7/B7)*
> *CEC L-117-20 VW TDI3 (replaces CEC L-078-99 VW TDI2) (all categories)*
> *ASTM D4739 TBN (all categories)*
> *ASTM D8256 Sequence VH Low Temperature Sludge Test (replaces ASTM D6593 Sequence VG) (all categories)*
> *ASTM D8279 Sequence X GDI Chain Wear Test (ACEA A7/B7)*
> *ASTM D8291 Sequence IX LSPI TGDI Test (ACEA A7/B7)*
> *ASTM D8350 Sequence IVB Valvetrain Wear Test (all categories)*

For lower SAPS ACEA C1 is removed and ACEA C6 introduced for high performance engines.
Nine key new performance tests are introduced:

> *CEC L-107-19 M271 Evo Sludge (replaces M271 Classic Sludge) (all categories)*
> *CEC L-114-19 Toyota Turbocharger Compressor Deposit Test 1KD-FTV (ACEA C6)*
> *CEC L-117-20 VW TDI3 (replaces CEC L-078-99 VW TDI2) (all categories)*
> *ASTM D4739 TBN (all categories except C2)*
> *ASTM D8256 Sequence VH Low Temperature Sludge Test (replaces ASTM D6593 Sequence VG) (all categories)*
> *ASTM D8279 Sequence X GDI Chain Wear Test (ACEA C6)*
> *ASTM D8291 Sequence IX LSPI TGDI Test (ACEA C6)*
> *ASTM D8350 Sequence IVB Valvetrain Wear Test (all categories)*
> *JASO FE M366 Fuel Economy Test (ACEA C6)*

Heavy Duty Engine Sequence Updates

The heavy-duty oil sequences update impacts the ACEA E category for high and lower SAPS.

For high SAPS additional tests included in ACEA E4/E7.
Three new performance tests are introduced:

> *CEC L-118-21 OM471 Piston Cleanliness (ACEA E4)*
> *ASTM D6750 Caterpillar 1N Piston Cleanliness (replaces CEC L-101-09 OM501LA) (ACEA E7)*
> *ASTM D6443 Chlorine (all categories)*

For lower SAPS we see the removal of ACEA E6/E9 category and the introduction of ACEA E8/E11.
Five key new performance tests are introduced:

> *CEC L-118-21 OM471 Piston Cleanliness (ACEA E8)*
> *ASTM D8048 Volvo T-13 Oxidation (ACEA E8/E11)*
> *ASTM D8047 Caterpillar Oil Aeration Test (ACEA E8/E11)*
> *ASTM D7549 Caterpillar C13 Piston Cleanliness (replaces CEC L-101-09 OM501LA) (ACEA E11)*
> *ASTM D6443 Chlorine (all categories)*

Conditions for Use of Performance Claims Against the ACEA Oil Sequences

ACEA requires that any claims by oil companies or oil distributors for oil performance to meet these Oil 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 Oil Sequences should be generated according to the European Engine Lubricants Quality Management System (EELQMS), available at www.eelqms.eu, but ACEA reserves the right to define alternatives in exceptional cases.

EELQMS 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[1], which forms part of the EELQMS, is mandatory for any claim to meet the requirements of this issue of the ACEA sequences. Therefore, ACEA requires that claims against the ACEA Oil Sequences can only be made by oil companies who have signed the EELQMS oil marketers' Letter of Conformance (for details: www.atiel.org).

The ACEA Oil Sequences are subject to continuous development. Replacement tests and other changes required by the European vehicle manufacturers are integrated and new issues are published on a regular basis. As new editions are published, older editions have to be withdrawn. The validity of old and new editions of the ACEA Oil Sequences are shown in the respective ACEA Oil Sequences.

Sequences Issue	First allowable use	Mandatory 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 LD	1st December 2016	1st December 2017	1st May 2023
2016 HD	1st December 2016	1st December 2017	1st May 2024
2021 LD	1st May 2021	1st May 2022	
2022 HD	1st May 2022	1st May 2023	

> ***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 supplier of any 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 are in the ATIEL Code of Practice.

[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), 14b Rue de la Science, 1040, Brussels, Belgium.

Certification and Registration

Claims against the ACEA Oil Sequences can be made on a self-certification basis. For any claim being made against these ACEA Oil Sequences, ACEA recommends oil suppliers to register their products with the ACEA Registration System on the ACEA website. Registration into the ACEA Registration System does not replace the required EELQMS oil marketers' Letter of Conformance registration in Services to Associations and Industry in the Lubricants (SAIL) sector.

All information needed for registration in ACEA Registration System is available on the ACEA website, see: https://app.acea.be/EOR

Engine oils claiming any of the ACEA Oil Sequences should be registered directly after their launch into the market in the ACEA Registration System and SAIL.

After completing the form on the ACEA website, it will be saved on the ACEA server. If claims are no longer needed, oil companies are asked to delete their registration. If registered claims continue to be used after three years, re-registration is recommended.

Nomenclature and ACEA Process

Each set of Oil Sequences is designated for consumer use by a two-part code comprising a letter to define the CLASS (e.g. C), and a number to define the CATEGORY (e.g. C2).

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/B4-21).

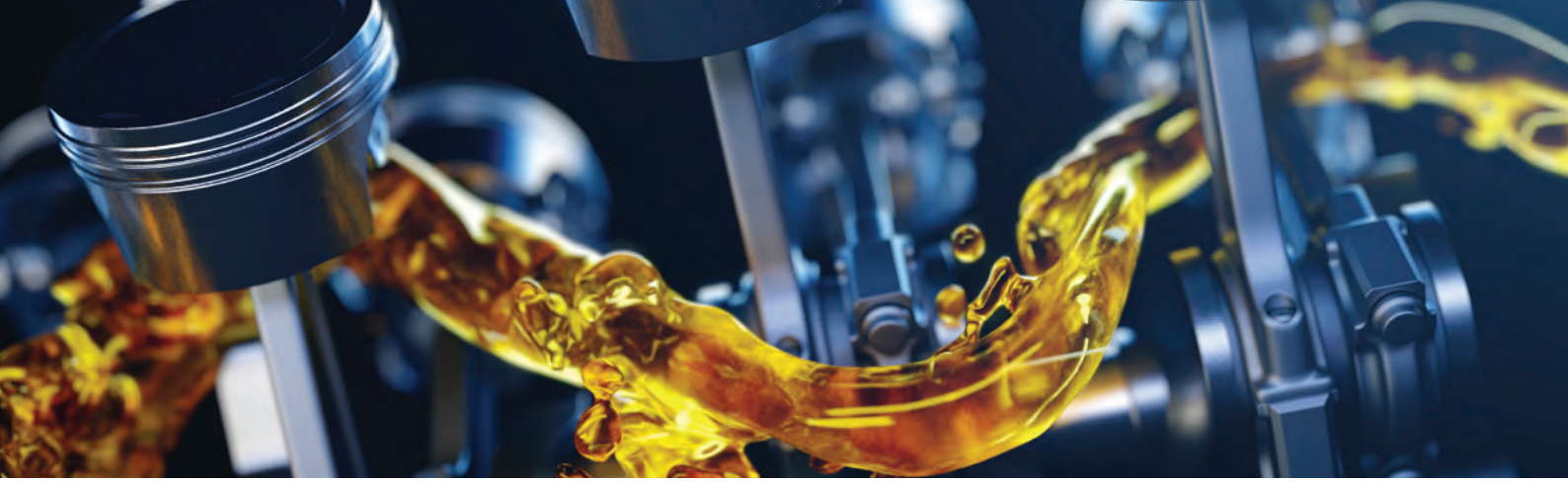
Classes may be added in future if, for example, Natural Gas engines, H_2 combustion engines or engines which operate with alternative fuels (e-fuels), may prove to require oil characteristics which cannot readily be incorporated into existing classes.

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 category are described in the Light Duty and Heavy Duty Sequence documents for guidance only. Specific applications of each category 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 suited to 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 Oil Sequences (e.g. product literature, packaging, labels) they must specify the ACEA Class and Category (see Nomenclature and ACEA Process for definitions).



Consumer Language

A/B: Gasoline and Diesel Engine Oils – High SAPS

A3/B3 Category is removed from these oil sequences. Stable, stay-in-grade engine oil intended for use in passenger car and light duty gasoline and diesel engines and/or for extended oil drain intervals where specified by the engine manufacturer.

A3/B4 Stable, stay-in-grade engine oil intended for use at extended drain intervals in passenger car and light duty gasoline and Direct Injection (DI) diesel engines, but also suitable for applications described under A3/B3.

A5/B5 Stable, stay-in-grade engine oil intended for use at extended drain intervals in passenger car and light duty gasoline and DI diesel engines designed for low viscosity engine oils with High Temperature High Shear (HTHS) viscosity of 2.9 to 3.5 mPa·s. These engine oils are unsuitable for use in certain engines – consult vehicle-OEM's owner's manual/handbook in case of doubt.

A7/B7 Stable, stay-in-grade engine oil intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed for low viscosity engine oils with HTHS viscosity of 2.9 to 3.5 mPa·s. Relative to A5/B5 these engine oils also provide Low Speed Pre-Ignition (LSPI) and wear protection for turbocharged gasoline DI engines as well as Turbocharger Compressor Deposit (TCCD) protection for modern DI diesel engines. These engine oils are unsuitable for use in certain engines – consult vehicle-OEM's owner's manual/handbook in case of doubt.

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

Note: These oils will increase the DPF/GPF and Three Way Catalyst (TWC) life and maintain the vehicle's fuel economy.
Warning: Some of these categories may be unsuitable for use in certain engine types – consult manufacturer's owner manual/handbook in case of doubt.

C1 Category is removed from these oil sequences.

C2 Stable, stay-in-grade engine oil with mid SAPS level, for aftertreatment system compatibility. Intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed for low viscosity engine oils with a minimum HTHS viscosity of ≥2.9 mPa·s.

C3 Stable, stay-in-grade engine oil with mid SAPS level, for aftertreatment system compatibility. Intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed for low viscosity engine oils with HTHS viscosity of a minimum of 3.5 mPa·s.

C4 Stable, stay-in-grade engine oil with low SAPS level, for aftertreatment system compatibility. Intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed for low viscosity engine oils with HTHS viscosity of minimum of 3.5 mPa·s.

C5 Stable, stay-in-grade engine oil for improved fuel economy, with mid SAPS level, for aftertreatment system compatibility. Intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed and OEM approved for engine oils with a HTHS viscosity of minimum 2.6 mPa·s.

C6 Stable, stay-in-grade engine oil for improved fuel economy with mid SAPS level, for aftertreatment system compatibility. Intended for use at extended oil drain intervals in passenger car and light duty gasoline and DI diesel engines designed and OEM approved for engine oils with HTHS viscosity of minimum 2.6 mPa·s. Relative to C5, these engine oils also provide LSPI and wear protection for turbocharged gasoline DI engines as well as Turbocharger Compressor Deposit (TCCD) protection for modern DI diesel engines.

Consumer Language

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 Exhaust Gas Recirculation (EGR) engines and some engines fitted with Selective Catalytic Reduction (SCR) NOx reduction systems. However, recommendations may differ between engine manufacturers so driver manuals and/or dealers must be consulted if in doubt.

E8 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 Selective Catalytic Reduction (SCR) NOx reduction systems. E8 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 must 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 must be consulted if in doubt.

E11 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. E11 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 should be consulted if in doubt.

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.

2021 ACEA Oil Sequences for Light-Duty Engines						May 2022 Revision 1
Requirement	**Test Method**	**Properties**	**Unit**	**Limits**		
				A3/B4-21	**A5/B5-21**	**A7/B7-21**
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-14-93 or ASTM D6278 or ASTM D7109	100 °C viscosity after 30 cycles	mm^2/s	All grades to be 'stay in grade'		
1.3 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	≥ 2.9 & ≤ 3.5
	CEC L-036-90	Dynamic viscosity at 100 °C and shear rate of 10^6 s^{-1}	mPa·s	–	Report	Report
1.4 Evaporative Loss	CEC L-040-93 (Noack)	Max. weight loss after 1 h at 250 °C	%	≤ 13		
1.5 TBN	ASTM D2896 ASTM D4739		mgKOH/g mgKOH/g	≥ 10.0 Report	≥ 8.0 Report	Report ≥ 6.0
1.6 Sulphur	ASTM D5185 or ASTM D4951		% m/m	Report		
1.7 Phosphorus	ASTM D5185 or ASTM D4951		% m/m	Report		
1.8 * Sulphated Ash	ASTM D874		% m/m	≥ 1.0 and ≤ 1.6	≤ 1.6	≤ 1.6
1.9 Chlorine	ASTM D6443		ppm	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:	Elastomer	RE6	RE7	RE8 / RE9
		- Tensile strength	%	Report		
		- Elongation at rupture	%	-70/+20	-65/+15	-51/+9 / -65/+19
		- Volume variation	%	-1.5/+1.8	-1.8/+7.7	0.0/+10.7 / -1.5/+13.8
1.11 Foaming Tendency	ASTM D892 with or 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	Tendency - stability	ml	Sequence IV (150 °C) 100 - nil		
1.13 Low Temperature Pumpability	CEC L-105-12	MRV	mPa·s	According to SAE J300 for fresh oil		
		Yield stress (MRV at SAE J300 temperatures, applicable for the fresh oil viscosity grade)	Pa			
1.14 Oil Oxidation with Biodiesel for Engine Oils Operating in the Presence of Biodiesel Fuel	CEC L-109-14	Oil oxidation at 168 h (DIN 51453)	A/cm	≤ 120	≤ 100	≤ 100
		Oil oxidation at 216 h (DIN 51453)	A/cm	Report	≤ 120	≤ 120
		Viscosity increase, relative at 168 h (Delta KV100)	%	≤ 150	≤ 60	≤ 60
		Viscosity increase, relative at 216 h (Delta KV100)	%	Report	≤ 150	≤ 150

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.

2021 ACEA Oil Sequences for Light-Duty Engines						May 2022 Revision 1
Requirement	**Test Method**	**Properties**	**Unit**	**Limits**		
				A3/B4-21	**A5/B5-21**	**A7/B7-21**
2. Engine tests						
2.1 * Gasoline DI Engine Cleanliness Test	CEC L-111-16 (EP6CDT)	Piston cleanliness	Merit	≥ RL259		
		Turbocharger Deposits **, average value of zones C, D, E & F	Merit	≥ 6.0		
2.2 * Low Temperature Sludge	ASTM D8256 (Sequence VH, Ford)	Average Engine Sludge	Merit	≥ 7.6		
		Rocker Cover Sludge	Merit	≥ 7.7		
		Average Engine Varnish	Merit	≥ 8.6		
		Average Piston Skirt Varnish	Merit	≥ 7.6		
		Comp. Ring (Hot Stuck)		None		
		Oil Screen Clogging	%	Report		
2.3 * Valvetrain Wear	ASTM D8350 (Sequence IVB, Toyota 2NR-FE)	Average intake lifter volume loss (8 position average)	mm^3	≤ 3.3	≤ 3.3	≤ 2.7
		End of test iron	ppm	≤ 400	≤ 400	≤ 400
2.4 * Black Sludge	CEC L-107-19 (M271 EVO)	Engine sludge, average	Merit	≥ 8.3		
2.5 * Fuel Economy	CEC L-54-96 (M111)	Fuel economy improvement	%	–	≥ 2.5	≥ 2.5
2.6 * DI Diesel Oil Dispersion at Medium Temperature	CEC L-106-14 (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 * DI Diesel Piston Cleanliness & Ring Sticking	CEC L-117-20 (VW TDI)	Piston cleanliness	Merit	≥ RL276 - 5		
		Cylinder-spreading limit	Merit	≤ 13		
		No Ring Sticking, max for any ring**	ASF	0		
2.8 * Turbocharger Compressor Deposit (Diesel)	CEC L-114-19 (Toyota 1KD-FTV)	Turbocharger rating	Merit	–		≥ 25
2.9 Low Speed Pre-Ignition GDI Turbo	ASTM D8291 (Sequence IX, Ford)	Pre-ignition events	Average number of events for 4 iterations	–		≤ 5
			Number of events per iteration	–		≤ 8
2.10 Chain Wear GDI	ASTM D8279 (Sequence X, Ford)	Elongation of timing chain	%	–		≤ 0.085

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

No. 1.8 *Maximum limits, values take into account method and production tolerances.*

No. 2.1, 2.6, 2.7 *** Parameter is not an official CEC parameter.*

No. 2.1 *The CEC L-111-16 (EP6) lifetime is limited. If the test becomes unavailable during the lifetime of these ACEA Engine Oil Sequences, ACEA intends to introduce a successor test on PSA hardware at a similar severity level.*

No. 2.2 *Alternatively, Sequence VG (ASTM D6593) at ACEA 2016 limits can be used in place of Sequence VH for all categories. The Sequence VG limits for ACEA 2016 are: Average engine sludge, merits: ≥ 7.8; Average rocker cover sludge, merits: ≥ 8.0; Average engine varnish, merits: ≥ 8.9;*
Average piston skirt varnish, merits: ≥ 7.5; Hotstuck compression rings: None; Oil screen clogging, % area: ≤ 20.

No. 2.3 *Alternatively, Sequence IVA (ASTM D6891) data can be used for A3/B4, A5/B5, C2, C3, C4 and C5 categories at the following limit: Cam wear average: max 90 microns.*

No. 2.4 *Alternatively to the CEC L-107-19 test, the Daimler M271 Sludge test procedure as described by Daimler AG can be used for all categories. For this test, reference oil changed from RL140 to RL261. Results relative to RL140 or RL261 can be used to demonstrate ACEA per formance. The applicable limit with RL261 is ≥ RL261 + 1σ. The applicable limit with RL140 is ≥ RL140 + 4σ. Test results obtained by the Daimler M271 test procedure will be accepted only under the condition that they come from test rigs being referenced and quality controlled by Daimler AG.*

No. 2.6 *The CEC L-106-16 (DV6C) lifetime is limited. If the test becomes unavailable during the lifetime of these ACEA Engine Oil Sequences, ACEA intends to introduce a successor test on PSA hardware at a similar severity level.*

No. 2.7 *Alternatively, CEC L-78-99 (TDI2) results can be used as specified in the table below.*

CEC L-78-99 limits applicable for:		A3/B4	A5/B5, A7/B7	C2	C3, C4, C5, C6
Piston Cleanliness	Merit	≥ RL206	≥ RL206	≥ RL206	≥ RL206
Ring Sticking (Rings 1 & 2)					
Average of all 8 rings	ASF	≤ 1.0	≤ 1.0	≤ 1.2	≤ 1.0
Max. for any 1st ring	ASF	≤ 1.0	≤ 1.0	≤ 2.5	≤ 1.0
Max for any 2nd ring	ASF	0.0	0.0	0.0	0.0
EoT TBN (ISO 3771) **	mgKOH/g	≥ 6.0	≥ 4.0	Report	Report
EoT TAN (ASTM D664) **	mgKOH/g	Report	Report	Report	Report

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Individual member companies may indicate performance parameters other than those covered by the tests shown or more stringent limits.

2021 ACEA Oil Sequences for Light-Duty Engines								May 2022 Revision 1
Requirement	**Test Method**	**Properties**	**Unit**	**Limits**				
				C2-21	**C3-21**	**C4-21**	**C5-21**	**C6-21**
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	100 °C viscosity after 30 cycles	mm^2/s	All grades to be 'stay in grade'				
1.3.1 HTHS Viscosity	CEC L-36-90	Dynamic viscosity at 150 °C and shear rate of 10^6 s^{-1}	mPa·s	≥ 2.9	≥ 3.5		≥ 2.6 & <2.9	
	CEC L-36-90	Dynamic viscosity at 100 °C and shear rate of 10^6 s^{-1}	mPa·s	Report				
1.4 Evaporative Loss	CEC L-40-93 (Noack)	Max. weight loss after 1 h at 250 °C	%	≤ 13		≤ 11	≤ 13	
1.5 TBN	ASTM D2896 ASTM D4739		mgKOH/g mgKOH/g	– –	≥ 6.0 Report			Report ≥ 4.0
1.6 * Sulphur	ASTM D5185 or ASTM D4951		% m/m	≤ 0.3		≤ 0.2	≤ 0.3	
1.7 * Phosphorus	ASTM D5185 or ASTM D4951		% m/m	≥ 0.07/≤ 0.09		≤ 0.09	≥ 0.07/≤ 0.09	
1.8 * Sulphated Ash	ASTM D874		% m/m	≤ 0.8		≤ 0.5	≤ 0.8	
1.9 Chlorine	ASTM D6443		ppm	Report				
1.10 Oil – Elastomer Compatibility		Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing:	Elastomer	RE6	RE7		RE8	RE9
		– Tensile strength	%	Report	Report		Report	Report
		– Elongation at rupture	%	-70/+20	-65/+15		-51/+9	-65/+19
		– Volume variation	%	-1.5/+1.8	-1.8/+7.7		0.0/+10.7	-1.5/+13.8
1.11 Foaming Tendency	ASTM D892 with or 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	Tendency - stability	ml	Sequence IV (150 °C) 100 - nil				
1.13 Low Temperature Pumpability	CEC L-105-12	MRV	mPa·s	According to SAE J300 for fresh oil				
		Yield stress (MRV at SAE J300 temperatures, applicable for the fresh oil viscosity grade)	Pa					
1.14 Oil Oxidation with Biodiesel for Engine Oils Operating in the Presence of Biodiesel Fuel	CEC L-109-14	Oil oxidation at 168 h (DIN 51453)	A/cm	≤ 100	≤ 100	≤ 100	≤ 100	≤ 100
		Oil oxidation at 216 h (DIN 51453)	A/cm	≤ 120	≤ 120	≤ 120	≤ 120	≤ 120
		Viscosity increase, relative at 168 h (Delta KV100)	%	≤ 60	≤ 60	≤ 60	≤ 60	≤ 60
		Viscosity increase, relative at 216 h (Delta KV100)	%	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150

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.

2021 ACEA Oil Sequences for Light-Duty Engines								May 2022 Revision 1
Requirement	**Test Method**	**Properties**	**Unit**	**Limits**				
				C2-21	**C3-21**	**C4-21**	**C5-21**	**C6-21**
2. Engine Tests								
2.1* Gasoline DI Engine Cleanliness	CEC L-111-16 (EP6CDT)	Piston Cleanliness	Merit	≥ RL259				
		Turbocharger Deposits **, average value of zones C, D, E & F	Merit	≥ 6.0				
2.2 * Low Temperature Sludge	ASTM D8256-19 (Sequence VH)	Average Engine Sludge	Merit	≥ 7.6				
		Rocker Cover Sludge	Merit	≥ 7.7				
		Average Engine Varnish	Merit	≥ 8.6				
		Average Piston Skirt Varnish	Merit	≥ 7.6				
		Compression Ring (hot stuck)		None				
		Oil Screen Clogging	%	Report				
2.3 * Valvetrain Wear	ASTM D8350 (Sequence IVB, Toyota 2NR-FE)	Average Intake Lifter Volume Loss (8 position average)	mm^3	≤ 3.3				≤ 2.7
		End of Test Iron	ppm	≤ 400				≤ 400
2.4 * Black Sludge	CEC L-107-19 (M271 EVO)	Engine Sludge, average	Merit	≥ 8.3				
2.5 Fuel Economy	CEC L-54-96 (M111)	Fuel Economy Improvement	%	≥ 2.5	≥ 1.0 (for xW-30 only, no limit for xW-40)		≥ 3.0	–
	JASO FE M366 (Toyota 2ZR-FXE)	Fuel Economy Improvement	%	–				≥ 0.0
2.6 * DI Diesel Oil Dispersion at Medium Temperature	CEC L-106-14 (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 * DI Diesel Piston Cleanliness & Ring Sticking	CEC L-117-20 (VW TDI)	Piston Cleanliness	Merit	≥ RL276 - 5				
		Cylinder-spreading limit**	Merit	≤ 13				
		No Ring Sticking, max for any ring**	ASF	0				
2.8 Turbocharger Compressor Deposit (Diesel)	CEC L-114-19 (Toyota 1KD-FTV)	Turbocharger rating	Merit	–				≥ 25
2.9 Low Speed Pre-Ignition GDI Turbo	ASTM D8291 (Sequence IX, Ford)	Pre-Ignition events	Average number of events for 4 iterations	–				≤ 5
			Number of events per iteration	–				≤ 8
2.10 Chain Wear GDI	ASTM D8279 (Sequence X, Ford)	Elongation of Timing Chain	%	–				≤ 0.085

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

No. 1.6, 1.7, 1.8 Maximum limits, values take into account method and production tolerances.

*No. 2.1, 2.6, 2.7 ** Parameter is not an official CEC parameter.*

No. 2.1 The CEC L-111-16 (EP6) lifetime is limited. If the test becomes unavailable during the lifetime of these ACEA Engine Oil Sequences, ACEA intends to introduce a successor test on PSA hardware at a similar severity level.

No. 2.2 Alternatively, Sequence VG (ASTM D6593) at ACEA 2016 limits can be used in place of Sequence VH for all categories. The Sequence VG limits for ACEA 2016 are: Average engine sludge, merits: ≥ 7.8; Average rocker cover sludge, merits: ≥ 8.0; Average engine varnish, merits: ≥ 8.9; Average piston skirt varnish, merits: ≥ 7.5; Hotstuck compression rings: None; Oil screen clogging, % area: ≤ 20.

No. 2.3 Alternatively, Sequence IVA (ASTM D6891) data can be used for A3/B4, A5/B5, C2, C3, C4 and C5 categories at the following limit: Cam wear average: max 90 microns.

No. 2.4 Alternatively to the CEC L-107-19 test, the Daimler M271 Sludge test procedure as described by Daimler AG can be used for all categories. For this test, reference oil changed from RL140 to RL261. Results relative to RL140 or RL261 can be used to demonstrate ACEA performance. The applicable limit with RL261 is ≥ RL261 + 1σ. The applicable limit with RL140 is ≥ RL140 + 4σ. Test results obtained by the Daimler M271 test procedure will be accepted only under the condition that they come from test rigs being referenced and quality controlled by Daimler AG.

No. 2.6 The CEC L-106-16 (DV6C) lifetime is limited. If the test becomes unavailable during the lifetime of these ACEA Engine Oil Sequences, ACEA intends to introduce a successor test on PSA hardware at a similar severity level.

No. 2.7 Alternatively, CEC L-78-99 (TDI2) results can be used as specified in the table below.

CEC L-78-99 limits applicable for:		A3/B4	A5/B5, A7/B7	C2	C3, C4, C5, C6
Piston Cleanliness	Merit	≥ RL206	≥ RL206	≥ RL206	≥ RL206
Ring Sticking (Rings 1 & 2)					
Average of all 8 rings	ASF	≤ 1.0	≤ 1.0	≤ 1.2	≤ 1.0
Max. for any 1st ring	ASF	≤ 1.0	≤ 1.0	≤ 2.5	≤ 1.0
Max for any 2nd ring	ASF	0.0	0.0	0.0	0.0
EoT TBN (ISO 3771) **	mgKOH/g	≥ 6.0	≥ 4.0	Report	Report
EoT TAN (ASTM D664) **	mgKOH/g	Report	Report	Report	Report

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.

2022 ACEA Oil Sequences for Heavy-Duty Engines							May 2022 Revision 0
Requirement	**Test Method**	**Properties**	**Unit**	**Limits**			
				E4-22	**E8-22**	**E7-22**	**E11-22**
1. Laboratory tests							
1.1 Viscosity		SAE J300 - latest active Issue		No restriction except as defined by shear stability and HTHS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC L-14-93 or ASTM D6278 or ASTM D7109	Viscosity after 30 cycles measured at 100 °C	mm²/s	Stay in grade			
	ASTM D7109	Viscosity after 90 cycles measured at 100 °C	mm²/s		Stay in grade		
1.3 HTHS Viscosity	CEC L-36-90	Dynamic viscosity at 150 °C and shear rate of 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-40-93 (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 or D4951		% m/m		≤ 0.08		≤ 0.12
1.7 Sulphur	ASTM D5185 or D4951		% m/m		≤ 0.3		≤ 0.4
1.8 Chlorine	ASTM D6443		% m/m	Report			
1.9 Oil/Elastomer Compatibility	CEC L-112-16	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		All Elastomers required for all categories			
				RE6	**RE7**	**RE8**	**RE9**
		- Tensile Strength	%	Report	Report	Report	Report
		- Elongation at Break	%	-70/+20	-65/+15	-51/+9	-65/+19
		- Volume Change	%	-1.5/+1.8	-1.8/+7.7	0.0/+10.7	-1.5/+13.8
1.10 Foaming Tendency	ASTM D892 without option A	Tendency – stability Tendency – stability Tendency – stability	ml ml ml	Sequence I (24 °C) 10 – nil Sequence II (94 °C) 20 – nil Sequence III (24 °C) 10 – nil			
1.11 High Temperature Foaming Tendency	ASTM D6082	Tendency - stability	ml	Sequence IV (150 °C) 200-50			
1.12 Oxidation	CEC L-85-99 (PDSC)	Oxidation induction time	min.	≥ 65			
1.13 Corrosion	ASTM D6594	Copper increase	ppm	Report			≤ 20
		Lead increase	ppm	Report		≤ 100	
		Copper strip rating	max	Report			3
1.14 * TBN	ASTM D2896		mg KOH/g	≥ 12	≥ 7	≥ 9	≥ 7
1.15 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			
1.16 Oil Oxidation with Biodiesel	CEC L-109-14	Oxidation increase after 168 h KV100 increase after 168 h	A/cm %	≤ 90 ≤ 130	≤ 80 ≤ 130	≤ 120 ≤ 300	≤ 90 ≤ 150

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.

2022 ACEA Oil Sequences for Heavy-Duty Engines							May 2022 Revision 0
Requirement	Test Method	Properties	Unit	Limits			
				E4-22	E8-22	E7-22	E11-22
2. Engine Tests							
2.1 Wear	CEC L-99-08 (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		≤ 2.1	≤ 2.1	≤ 2.1	≤ 2.1
2.31 * Piston Cleanliness	CEC L-118-21 (OM471)	Piston cleanliness (grooves and piston undercrown), average Oil consumption	% g/h	≥ 74 Report	≥ 74 Report		
2.32 * Piston Cleanliness	ASTM D6750 (CAT 1N)	Weighted demerits (WDN) Top groove fill (TGF) Top land heavy carbon (TLHC) Oil consumption (0 h-252 h) Piston, ring and liner scuffing Piston ring sticking	Demerits % % g/kWh			≤ 286.2 ≤ 20 ≤ 3 ≤ 0.54 None None	
2.33 * Piston Cleanliness	ASTM D7549 (CAT C13)	Merit rating Hot stuck rings	Merit				≥ 1000 None
2.4 * Soot Induced Wear	ASTM D7468 (Cummins ISM)	Merit rating Top ring mass loss Crosshead, weight loss Oil filter diff. press at 150 h Engine sludge Adj. screw weight loss	Merit mg mg kPa Merit mg			≤ 7.5 ≤ 55 ≥ 8.1	≥ 1000 ≤100 ≤7.1 ≤19 ≥8.7 ≤49
2.5 * Wear (liner-ring-bearings)	ASTM D7422 (Mack T-12)	Merit rating Cylinder liner wear (CLW) Top ring weight loss (TRWL) End of test lead Delta lead 250-300 hrs Oil consumption (Phase II)	Merit µm mg ppm ppm g/hr		≥ 1000 ≤ 24.0 ≤ 105 Report Report Report	≥ 1000 ≤ 26 ≤ 117 ≤ 42 ≤ 18 ≤ 95	≥ 1000 ≤ 24.0 ≤ 105 Report Report Report
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 + 6 Report Report		≥ RL255 + 4 Report Report
2.7 Oxidation stability	ASTM D8048 (Volvo T-13)	KV increase (300-360 h) Oxidation peak height Nitration peak height Oil consumption (avg. 48-192 h)	% A/cm A/cm g/h		≤ 75 ≤ 125 Report Report		≤ 75 ≤ 125 Report Report
2.8 Aeration	ASTM D8047 (COAT)	Aeration	%		≤ 11.8		≤ 11.8

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

No. 1.14 — *For ACEA E7, values < 9.00 are not accepted.*

No.2 — *Unless otherwise stated, for ASTM engine tests in these ACEA HD Sequences, data meeting the requirements of API CK-4 are acceptable, including Multiple Test Evaluation Procedures (MTEP).*

No. 2.2 — *ASTM D5967 (Mack T-8E): Data meeting the requirements of API CH-4 are acceptable, including Multiple Test Evaluation Procedures (MTEP).*
Mack T-11 results obtained as part of an API CI-4, CI-4 plus, CJ-4, CK-4 or FA-4 approval programme can be used in place of Mack T-8E.

No. 2.31 — *CEC L-118-21 (OM471): Alternatively, CEC L-101-09 (OM501LA) data meeting the requirements of ACEA E4-16 can be used to support an ACEA E4 claim.*

No. 2.32 — *ASTM D6750 (CAT 1N): Alternatively, CEC L-101-09 (OM501LA) data meeting the requirements of ACEA E7-16 can be used to support an ACEA E7 claim.*

No. 2.33 — *ASTM D7549 (CAT C13): Alternatively, CEC L-101-09 (OM501LA) data meeting the requirements of ACEA E9-16 can be used to support an ACEA E11 claim.*

No. 2.4 — *ASTM D7468 (Cummins ISM): For ACEA E7, data meeting the requirements of API CI-4 are acceptable, including Multiple Test Evaluation Procedures (MTEP).*
For ACEA E11, merit number shall be calculated according to the API CK-4 specification.

No. 2.5 — *ASTM D7422 (Mack T-12):*
For ACEA E7 only:
Data meeting the requirements of API CI-4 are acceptable, including Multiple Test Evaluation Procedures (MTEP). Merit number shall be calculated according to the API CI-4 specification.
Mack T-10 results obtained as part of an API CI-4 or CI-4 plus approval programme can be used in place of Mack T-12.
Mack T-12 Cylinder Liner Wear and Top Ring Weight Loss results obtained as part of an API CK-4 or FA-4 approval programme 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.

No. 2.6 — *** Not CEC approved parameters.*

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