ACEA Oil Sequences 2023

SERVICE FILL OILS FOR GASOLINE ENGINES, LIGHT-DUTY DIESEL ENGINES, ENGINES WITH AFTERTREATMENT DEVICES AND HEAVY-DUTY DIESEL ENGINES

Performance you can rely on.

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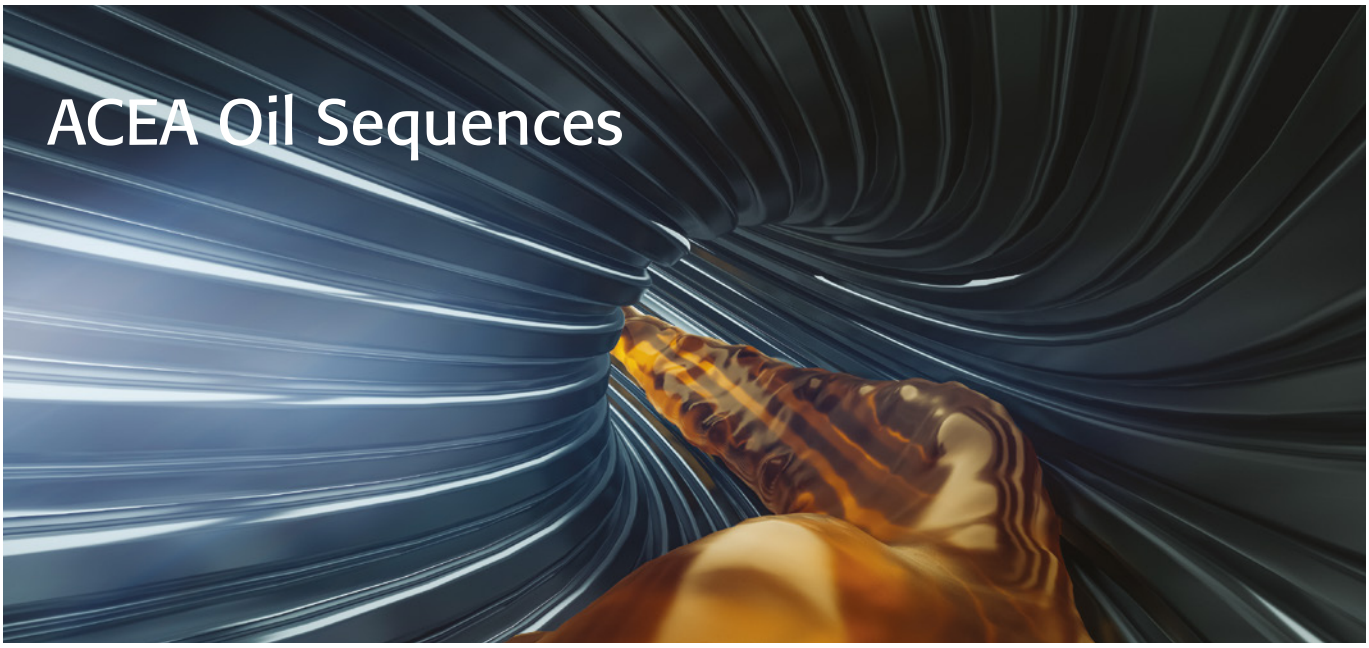

ACEA Oil Sequences

This publication has been derived from the official ACEA Oil Sequences documents, the latest versions of which can be found at: **www.acea.auto**

The accuracy of this publication is the responsibility of Infineum, the aforementioned original documents on **www.acea.auto** remains the sole point of reference and will be updated in case of any changes to the ACEA Oil Sequences.

The latest sequences have been designed to address engine developments that are being driven by both regulatory and performance needs, complemented by necessary test maintenance requirements.

Light Duty Engine Oil Sequence Updates

The ACEA A/B high SAPS category and the ACEA C lower SAPS categories have been updated with:

- New C7 category introduced
- OM646LA wear test re-introduced for legacy categories

Heavy Duty Engine Oil Sequence Updates

The ACEA E high and lower SAPS category have been updated as follows:

The ACEA E6 and E9 categories have been removed and are now replaced by the ACEA E8 and E11 categories, respectively, both of which now include the Caterpillar Oil Aeration Test (ASTM D8047) and the Volvo T-13 oxidation engine test (ASTM D8048).

Furthermore, the OM501LA piston cleanliness test (CEC L-101-09) has now been replaced by the OM471 test (CEC L-118-21) in ACEA E4 and E8, by the Cat 1N test (ASTM D6750) in ACEA E7, and by the Cat C13 test (ASTM D7549) in ACEA E11.

Finally the reporting of the chlorine content (ASTM D6443) is now mandatory in all heavy-duty engine oil categories.

Conditions for use of performance claims against the ACEA Oil Sequences

ACEA requires that any claims 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 or oil distributors who have signed the EELQMS oil marketers' Letter of Conformance **(for details: www.atiel.eu)**.

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. 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 Oil 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
ACEA Heavy-Duty engine oil sequences			
2016	1 December 2016	1 December 2017	1 May 2024
2022	1 May 2022	1 May 2023	
ACEA Light-Duty engine oil sequences			
2016	1 December 2016	1 December 2017	1 May 2023
2021	1 May 2021	1 May 2022	1 August 2025
2023	12 September 2023	12 September 2024	

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 Sequence Issue. Up to that date new claims can also be made according to the previous ACEA Oil 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 any oil claiming ACEA performance requirements is responsible for all aspects of product liability.

In the tables in the next pages, 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), ATIEL, Rue Belliard 40, 1040 Brussels, Belgium.

ACEA	ACEA 2023 European oil sequence for service-fill oils for gasoline and light-duty diesel engines	Sep 2023 Rev.0

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.

1. LABORATORY TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS		
				A3/B4-23	A5/B5-23	A7/B7-23
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-36-90	Dynamic viscosity at 150 °C and shear rate of 10^6 s^{-1}	mPa·s	≥ 3.5	≥ 2.9 and ≤ 3.5	
	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		
1.5 TBN	ASTM D2896		mgKOH/g	≥ 10.0	≥ 8.0	Report
	ASTM D4739		mgKOH/g	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	
1.9 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 type		
				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	≤ 120	≤ 100	
		Oil oxidation at 216 h (EOT) (DIN 51453)	A/cm	Report	≤ 120	
		Viscosity increase, relative at 168 h (Delta KV100)	%	≤ 150	≤ 60	
		Viscosity increase, relative at 216 h (Delta KV100 at EOT 216 h)	%	Report	≤ 150	

*/**: Footnotes referring to the following Requirements in the A-/B- and C-Classes:
No 1.6, 1.7, 1.8 Maximum limits, values take into account method and production tolerances

ACEA	ACEA 2023 European oil sequence for service-fill oils for gasoline and light-duty diesel engines	Sep 2023 Rev.0

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

2. ENGINE TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS		
				A3/B4-23	A5/B5-23	A7/B7-23
2.1 **Gasoline DI engine cleanliness test**	CEC L-111-16 (EP6CDT)	Piston cleanliness	Merit	≥ RL259		
		Turbo charger deposits **, average value of zones C, D, E & F	Merit	≥ 6.0		
2.2 **Low temperature sludge***	ASTM D8256 (Sequence VH)	Average engine sludge	Merit	≥ 7.6		
		Rocker cover sludge	Merit	≥ 7.7		
		Average piston skirt varnish	Merit	≥ 7.6		
		Average engine varnish	Merit	≥ 8.6		
		Compression ring (hot stuck)		none		
		Oil screen clogging	%	Report		
2.3 **Valve train 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	
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 **Diesel engine wear***	CEC L-99-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 120		
		Cam wear inlet (avg. max. wear 8 cams) **	µm	≤ 100		
		Cylinder wear (avg. 4 cylinders) **	µm	≤ 5.0		
		Bore polishing (13 mm) ** (max. value of 4 cylinders)	%	≤ 3.0		
		Tappet wear inlet ** (avg. max. wear 8 cams)	µm	Report		–
		Tappet wear outlet ** (avg. max. wear 8 cams)	µm	Report		
		Piston cleanliness (avg. 4 pistons) **	Merit	≥ 12		
		Engine sludge average **	Merit	≥ 8.8		
2.8 **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		
2.9 **Turbocharger compressor deposit (diesel)**	CEC L-114-19 (Toyoya 1KD-FTV)	Turbocharger rating	Merit	–		≥ 25
2.10 **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
2.11 **Chain wear GDI**	ASTM D8279 (Sequence X, Ford)	Elongation of timing chain	%	–		≤ 0.085

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

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 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) results meeting ACEA 2016 requirements 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; Hot-stuck 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, results of the Daimler M271 sludge test as described by Daimler AG can be used for A3/B4, A5/B5 and C2, C3, C4, C5. 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 Oil Sequences, ACEA intends to introduce a successor test on PSA hardware at a similar severity level.

No 2.7 CEC L-99-08 (Diesel Engine wear) is reintroduced in the 2023 sequence for following oil categories: A3/B4, A5/B5, C2, C3, C4 and C5. By reintroduction of this test in 2023 all claims according to ACEA-23 of the before mentioned ACEA categories have to run the test.

No 2.8 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, C7
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

ACEA	ACEA 2023 European oil sequence for service-fill oils for gasoline and light-duty diesel engines with after treatment devices	Sep 2023 Rev.0

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1. LABORATORY TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS					
				C2-23	C3-23	C4-23	C5-23	C6-23	C7-23
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-36-90	Dynamic viscosity at 150 °C and shear rate of 10^6 s^{-1}	mPa·s	≥ 2.9	≥ 3.5		≥ 2.6 and < 2.9		≥ 2.3 and < 2.6
	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		mgKOH/g	–	≥ 6.0			Report	
	ASTM D4739		mgKOH/g	–	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*	CEC L-112-16	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing:		Elastomer type					
				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 168h (DIN 51453)	A/cm	≤ 100					
		Oil oxidation at 216h (EOT) (DIN 51453)	A/cm	≤ 120					
		Viscosity increase, relative at 168h (Delta KV100)	%	≤ 60					
		Viscosity increase, relative at 216h (Delta KV100)	%	≤ 150					

*/**: Footnotes referring to the following Requirements in the A-/B- and C-Classes:
No 1.6, 1.7, 1.8 Maximum limits, values take into account method and production tolerances

ACEA	ACEA 2023 European oil sequence for service-fill oils for gasoline and light-duty diesel engines with after treatment devices	Sep 2023 Rev.0

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2. ENGINE TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS					
				C2-23	C3-23	C4-23	C5-23	C6-23	C7-23
2.1 Gasoline DI engine cleanliness	CEC L-111-16 (EP6CDT)	Piston cleanliness	Merit	≥ RL259					
		Turbo charger deposits **, average value of zones C, D, E & F	Merit	≥ 6.0					
2.2 Low temperature sludge*	ASTM D8256 (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 Valve train 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-109-19 (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	≥ 0.3
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 Diesel engine wear*	CEC L-99-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 120	≤ 120				
		Cam wear inlet (avg. max. wear 8 cams) **	µm	≤ 100	≤ 100				
		Cylinder wear (avg. 4 cylinders) **	µm	≤ 5.0	≤ 5.0				
		Bore polishing (13 mm) ** (max. value of 4 cylinders)	%	≤ 3.0	≤ 3.0				
		Tappet wear inlet ** (avg. max. wear 8 cams)	µm	Report	Report				
		Tappet wear outlet ** (avg. max. wear 8 cams)	µm	Report	Report				
		Piston cleanliness (avg. 4 pistons) **	Merit	Report	≥ 12				
		Engine sludge average **	Merit	Report	≥ 8.8				
2.8 DI diesel piston cleanliness & ring sticking*	CEC L-117-20 (VW TDI)	Piston cleanliness	Merit	≥ RL276 - 5					
		Cylinder-spreading limit **	Merit	≤ 13					
		No ring sticking, max for any ring **	ASF	0					
2.9 Turbocharger compressor deposit (diesel)	CEC L-114-19 (Toyota 1KD-FTV)	Turbocharger rating	Merit	–				≥ 25	
2.10 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	
2.11 Chain wear GDI	ASTM D8279 (Sequence X, Ford)	Elongation of timing chain	Merit	–				≤ 0.085	

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

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 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) results meeting ACEA 2016 requirements 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; Hot-stuck 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, results of the Daimler M271 sludge test as described by Daimler AG can be used for A3/B4, A5/B5 and C2, C3, C4, C5. 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 2.7 CEC L-99-08 (Diesel Engine wear) is reintroduced in the 2023 sequence for following oil categories: A3/B4, A5/B5, C2, C3, C4 and C5. By reintroduction of this test in 2023 all claims according to ACEA-23 of the before mentioned ACEA categories have to run the test.

No 2.8 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, C7
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

ACEA	ACEA 2022 European oil sequence for service-fill oils for heavy-duty diesel engines	Oct 2023 Rev. 1

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

1. LABORATORY TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-22	E8-22	E7-22	E11-22
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.	mm^2/s	Stay in grade			
	ASTM D7109	Viscosity after 90 cycles measured at 100 °C	mm^2/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		Elastomer type			
				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	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 Lead increase Copper strip rating	ppm ppm max.	Report Report Report		Report ≤ 100 Report	≤ 20 ≤ 100 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

*/**: Footnotes referring to the following requirements:

No 1.9 Testing on all 4 materials RE6 through RE9 is required for each of the ACEA E categories.

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

ACEA	ACEA 2022 European oil sequence for service-fill oils for heavy-duty diesel engines	Oct 2023 Rev. 1

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.

2. ENGINE TESTS

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				E4-22	E8-22	E7-22	E11-22
2.1 Wear	CEC L-99-08 (OM646LA)	Cam wear outlet (avg. max. wear 8 cams)	µm	≤ 140		≤ 155	
2.2 Soot in oil*	ASTM D5967 (Mack T-8E)	Test duration 300 h Relative viscosity at 4.8% soot and 50% shear loss		≤ 2.1			
2.31 Piston cleanliness*	CEC L-118-21 (OM471)	Piston cleanliness (grooves and piston undercrown), average Oil consumption	% g/h	≥ 74 Report			
2.32 Piston cleanliness*	ASTM D6750 (CAT 1N)	Weighted demerits (WDN) Top groove fill (TGF) Top land heavy carbon (TLHC) Oil consumption (0-252 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 150h 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 T12)	Merit 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/h		– ≤ 24.0 ≤ 105 Report Report Report	≥ 1000 ≤ 26 ≤ 117 ≤ 42 ≤ 18 ≤ 95	– ≤ 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 (300-360h) Oxidation peak height Nitration peak height Oil consumption (avg 48-192h)	% 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:

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 program, 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. Alternatively, CEC L 118 21 (OM471) data meeting the requirements of ACEA E4 22 / E8 22 can be also be used to support an ACEA E7 22 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. Alternatively, CEC L 118 21 (OM471) data meeting the requirements of ACEA E4 22 / E8 22 can be also be used to support an ACEA E11 22 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 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 program, 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 program, which includes a passing Volvo T-13 at the API CK-4 or API FA-4 level, may be used to satisfy the requirements of the Mack T-12 in the ACEA Oil Sequences.

No. 2.6 ** Not CEC approved parameters.

Certification and registration

Claims against the ACEA Oil Sequences can be made on a self-certification basis. For any claim being made, ACEA recommends that oil suppliers register their products with the ACEA registration system on the ACEA website after their launch into the market. Registration does not replace the required EELQMS oil marketers' letter of conformance registration in SAIL (Services to Associations and Industry in the Lubricants sector) **www.sail-europe.eu/**.

All information needed for registering in ACEA's registration system is available on ACEA's website - **https://app.acea.be/EOR**. After the form is completed, 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.

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 & ACEA Process for definitions).

Each set of ACEA Oil Sequences is designated for consumer use by a two-part code comprising a letter to define the class (eg C), and a number to define the category (eg C2).

In addition, for industry use, each sequence has a two-digit number to identify the year of implementation of that severity level (eg A3/B4-21).

Classes may be added in future if, for example, natural gas engines, H2 combustion engines or engines which operate with alternative fuels (e-fuels), 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 each ACEA Oil Sequences document are intended only for industry use and indicate 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 (eg 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).

Consumer language

A/B : Gasoline and diesel engine oils – 'High SAPS'

A3/B4 Stable, stay-in-grade engine oil intended for use in passenger car and light-duty gasoline & diesel engines and/or for extended oil drain intervals where specified by the engine manufacturer.

A5/B5 Stable, stay-in-grade engine oil intended for use at extended oil drain intervals in passenger car and light-duty gasoline & DI diesel engines designed for low viscosity engine oils with 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 & 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 provide also low speed pre-ignition- 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 TWC life and maintain the vehicle's fuel economy.*

Warning: *Some of these categories may be unsuitable for use in certain engine types – consult the manufacturer's owner manual/handbook in case of doubt.*

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 & 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 & DI diesel engines designed for engine oils with HTHS viscosity of minimum 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 & DI diesel engines designed for engine oils with HTHS viscosity of minimum 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 & DI diesel engines designed and OEM-approved for engine oils with 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 & 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 provide also low speed pre-ignition- and wear protection for turbocharged gasoline DI engines as well as turbocharger compressor deposit (TCCD) protection for modern DI diesel engines.

C7 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 & DI diesel engines designed and OEM-approved for engine oils with HTHS viscosity of minimum 2.3 mPa·s. C7 is based on C6 performance levels, with the exception of enhanced fuel economy.

SAPS: Sulphated Ash, Phosphorus, Sulphur
HTHS: High Temperature High Shear Viscosity
DI: Direct Injection
DPF: Diesel Particle Filter
GPF: Gasoline Particle Filter
TWC: Three-Way Catalyst

E : Heavy Duty Diesel engine oils

OEM manual is mandatory, the below table gives an overview
For oil drain interval information please refer to the OEM manual

Engine Oil Sequence	Euro VI Stage IIIb, IV, V	Euro I, II, III, IV, V Stage I, II, IIIa	EGR engine compatibility	Exhaust treatment (DPF, SCR & Catalyst)	Fuel compatibility		How to read the table
					High sulphur*	Biodiesel**	
E4	✘	!	!	✘	✔	!	✔ recommended ! for some applications ✘ not recommended
E7	✘	!	✔	✘	✔	!	
E8	✔	✔	✔	✔	!	✔	
E11	✔	✔	✔	✔	!	✔	

* >50 ppm Sulphur
** Recommendations may differ between engine manufacturers, especially with >B7 biodiesel blends; please consult driver manuals and/or dealers if in doubt.

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