ACEA
European
Automobile
Manufacturers
Association

ACEA EUROPEAN OIL SEQUENCES

2002

SERVICE FILL OILS FOR
GASOLINE ENGINES
LIGHT DUTY DIESEL ENGINES
HEAVY DUTY DIESEL ENGINES

Laboratory tests for gasoline engine oils,
Engine tests for gasoline engine oils,
Laboratory tests for light duty diesel engine oils,
Engine tests for light duty diesel engine oils,
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 2002 European Oil Sequences for Service-fill Oils for Gasoline engines, for Light Duty Diesel engines, 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 1999 sequences as a means of defining engine lubricant quality from 1st February 2002.

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.

All engine performance testing used to support a claim of compliance with these ACEA sequences must be generated according to the European Engine Lubricants Quality Management System (EELQMS). This system, which is described in the ATIEL Code of Practice[1], addresses product development testing and product performance documentation, and involves the registration of all candidate and reference oil testing and defines the compliance process. Compliance with the ATIEL Code of Practice is mandatory for any claim to meet the requirements of the 2002 issue of these ACEA sequences.

Issue year*	First allowable use	New claims by	Withdrawn
1996	1st March 1996	1st March 1997	1st March 2000
1998	1st March 1998	1st March 1999	1st March 2002
1999	1st September 1999	1st September 2000	1st February 2004
2002	1st February 2002	1st February 2003	

*) Issue year of full document

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

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

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

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

The ACEA 2002 European Oil Sequences for Service-fill Oils comprise 3 sets (classes) of sequences: one for Gasoline engines; one for Light Duty Diesel engines; and one for Heavy Duty Diesel engines. Within each of these sets there are categories which reflect different performance requirements - four (A1, A2 A3 & A5) for gasoline engines; five (B1, B2, B3, B4 & B5) for light duty diesel engines; and four (E2, E3, E4 & E5) 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 motor 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. A), and a number to define the CATEGORY (e.g. A1).

In addition, for industry use, each sequence has a two-digit number to identify the YEAR of implementation of that severity level (e.g. A1-02). An ISSUE number may also be included where requirements have been updated without a change in severity. (e.g. A2-96 Issue 3.)

The CLASS indicates oil intended for a general type of engine - currently A = gasoline engines; B = light duty diesel engines; E = heavy duty diesel engines. Other classes may be added in future if, for example, Natural Gas engines prove to require oil characteristics which cannot readily be incorporated into existing classes.

The CATEGORY indicates oils for different purposes or applications within that general class, related to some aspect or aspects of the performance level of the oil. Typical applications for each sequence are described below for guidance only. Specific applications of each sequence are the responsibility of the individual motor manufacturer for his 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 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 for the category to meet new / uprated 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.).

The ACEA Development Decision Guidelines for the update process are shown in Appendix A

CONSUMER LANGUAGE:

Gasoline Sequences

A1 Oil intended for use in gasoline engines specifically designed to be capable of using low friction, low viscosity oils with a High Temperature / High Shear Rate Viscosity of 2.6 to 3.5 mPa.s. These oils may be unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

A2 General purpose oil intended for use in most gasoline engines with normal drain intervals, although it may not be suitable for some high performance engines.

A3 Stable, stay-in-grade oil intended for use in high performance gasoline 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.

A4 Reserved for future use for gasoline direct injection engines.

A5 Stable, stay-in-grade oil intended for use at extended drain intervals in high performance gasoline engines designed to be capable of using low friction, low viscosity oils with a HT/HS of 2.9 to 3.5 mPa.s. These oils may be unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

Light duty diesel Sequences

B1 Oil intended for use in car and 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 to 3.5 mPa.s. These oils may be unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

B2 General purpose oil intended for use in most car and light van diesel engines (primarily indirect injection) with normal drain intervals, although it may not be suitable for some high performance engines.

B3 Stable, stay-in-grade oil intended for use in high performance car and 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.

B4 Stable, stay-in-grade oils intended for use in cars and light vans having direct injection diesel engines but also suitable for applications described under B3

B5 Stable, stay-in-grade oil intended for use at extended drain intervals in car and light van diesel engines designed to be capable of using low friction, low viscosity oils with a HT/HS of 2.9 to 3.5 mPa.s. These oils may be unsuitable for use in some engines. Consult owner manual or handbook if in doubt.

Heavy duty diesel Sequences

E2 General purpose oil for naturally aspirated and turbocharged heavy-duty diesel engines, medium to heavy duty cycles and mostly normal oil drain intervals.

E3 This lubricant category provides effective control with respect to piston cleanliness, bore polishing, wear, soot handling and lubricant stability. It is therefore recommended for diesel engines meeting Euro 1 and Euro 2 emission requirements running under severe conditions. It is also suitable for extended oil drain intervals according to the manufacturer's recommendations.

E4 Stable, stay-in-grade oil providing further control of piston cleanliness, wear, soot handling and lubricant stability compared to E3. It is recommended for highly rated diesel engines meeting Euro 1, Euro 2 and Euro 3 emission requirements and running under very severe conditions, e.g. significantly extended oil drain intervals according to the manufacturers recommendations.

E5 Stable, stay-in-grade oil providing effective control with respect to piston cleanliness and bore polishing. It further provides improved wear and turbocharger deposit control, soot handling and lubricant stability compared to E3. It is recommended for highly rated diesel engines meeting Euro 1, Euro 2 and Euro 3 emission requirements and running under severe conditions, e.g. extended oil drain intervals according to the manufacturers recommendations.

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Performance parameters other than those covered by the tests shown or more stringent limits may be indicated by individual member companies.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				A1-02	**A2-96 Issue 3**	**A3-02**	**A4-nn**	**A5-02**
1. LABORATORY TESTS								
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.				
1.2 Shear stability	CEC-L-14-A-93 (Bosch Injector)	100°C Viscosity after 30 cycles xW-20 xW-30 xW-40 xW-50	mm^2/s	stay in grade ≥ 8.6 ≥ 12.0	≥ 9.0 ≥ 12.0 ≥ 15.0	All grades to be stay in grade		All grades to be stay in grade
1.3 Viscosity at high temp. & high shear rate	CEC-L-36-A-97 (Ravenfield)	Viscosity at 150°C and 10^6 s^{-1} shear rate	mPa.s	max. 3.5. xW-20 2.6. min All others 2.9 min.	>3.5	>3.5		min 2.9 max. 3.5
1.4 Evaporative loss	CEC-L-40-A-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 15	≤ 15 for 10W-x or lower. ≤ 13 for others	≤ 13		≤ 13
1.5 Sulfated ash	ASTM D874		% m/m	≤ 1.3	≤ 1.5	≤ 1.5		≤ 1.5
				NOTE: The following sections apply to all sequences				
1.6 Sulfur			ppm m/m	Report				
1.7 Phosphorus			ppm m/m	Report				
1.8 Chlorine			ppm m/m	Report				
1.9 Oil / elastomer compatibility See Notes (1)	CEC-L-39-T-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		RE1	Elastomer type RE2-99	RE3	RE4	AEM (VAMAC)
		Hardness DIDC	points	-1/+5	-5/+8	-25/+1	-5/+5	As per Daimler-Chrysler
		Tensile strength	%	-40/+10	-15/+18	-45/+10	-20/+10	
		Elongation at rupture	%	-50/+10	-35/+10	-20/+10	-50/+10	
		Volume variation	%	-1/+5	-7/+5	-1/+30	-5/+5	
1.10 Foaming tendency	ASTM D892 without option A	Tendency - stability	ml	Sequence I (24°C) 10 - nil Sequence II (94°C) 50 - nil Sequence III (24°C) 10 - nil				
1.11 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150°C) 100 - nil				

(1) Use either complete DaimlerChrysler requirements (VDA 675301, 7 days +/- 2h, 4 materials (NBR: NBR34 DIN 53538 T3 (100 ºC +/- 2°C); FPM: AK6 (150 ºC +/- 2°C); ACM: E7503 (150 ºC +/- 2°C); AEM: D 8948/200.1 (150 ºC +/- 2°C)) + RE3 according to requirement 1.9 above, or complete requirements according to 1.9 above + DC requirements for AEM.

New CEC RE3 material and limits are to be developed and added to Sequences as soon as possible.

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Performance parameters other than those covered by the tests shown or more stringent limits may be indicated by individual member companies.

REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				A1-02	**A2-96 Issue 3**	**A3-02**	**A4-nn**	**A5-02**
2. ENGINE TESTS								
2.1 High temperature deposits Ring sticking Oil thickening	CEC-L-88-T-xx (TU5JP – L4) 72 hour test	Ring sticking (each part) Piston varnish (6 elements) (average of 4 pistons) Absolute viscosity increase at 40°C between min and max values during test Oil consumption	merit merit mm^2/s kg/test	≥ 9.0 ≥ RL216 ≤ RL216 Report	≥ 9.0 ≥ RL216 ≤ 1.5 x RL216 Report	≥ 9.0 ≥ RL216 ≤ 0.8 x RL216 Report		≥ 9.0 ≥ RL216 ≤ 0.8 x RL216 Report
2.3 Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API (See Note (2))	Average engine sludge Rocker cover sludge Average Piston skirt varnish Average engine varnish Comp. ring (hot stuck) Oil screen clogging	merit merit merit merit %	≥ 7.8 ≥ 8.0 ≥ 7.5 ≥ 8.9 none ≤ 20	≥ 7.8 ≥ 8.0 ≥ 7.5 ≥ 8.9 none ≤ 20	≥ 7.8 ≥ 8.0 ≥ 7.5 ≥ 8.9 none ≤ 20		≥ 7.8 ≥ 8.0 ≥ 7.5 ≥ 8.9 none ≤ 20
2.4 Valve train scuffing wear	CEC-L-38-A-94 (TU3M)	Cam wear, average Cam wear, max. Pad merit (Ave. of 8 pads)	µm µm merit	≤ 10 ≤ 15 ≥ 7.5	≤ 10 ≤ 15 ≥ 7.5	≤ 10 ≤ 15 ≥ 7.5		≤ 10 ≤ 15 ≥ 7.5
2.5 Black sludge	CEC-L-53-T-95 (M111)	Engine sludge, average	merit	≥ RL140	≥ RL140	≥ RL140		≥ RL140
2.6 Fuel economy See Note (3)	CEC-L-54-T-96 (M111)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 2.5	--	--		≥ 2.5

(2) 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.
(3) ACEA considers the CEC L-54-T-96 test the only valid comparator against which claims of lubricant fuel economy improvement should be made.

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REQUIREMENT	TEST METHOD	PROPERTIES	UNIT	LIMITS				
				B1-02	**B2-98 Issue 2**	**B3-98 Issue 2**	**B4-02**	**B5-02**
1. LABORATORY TESTS								
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.				
1.2 Shear stability	CEC-L-14-A-93 (Bosch Injector)	100°C Viscosity after 30 cycles xW-20 xW-30 xW-40 xW-50	mm^2/s	Stay in grade ≥ 8.6 ≥ 12.0	 ≥ 9.0 ≥ 12.0 ≥ 15.0	All grades to be stay in grade	All grades to be stay in grade	All grades to be stay in grade
1.3 Viscosity at high temp. & high shear rate	CEC-L-36-A-97 (Ravenfield)	Viscosity at 150°C and 10^6 s^{-1} shear rate	mPa.s	max. 3.5. xW-20 2.6. min All others 2.9 min.	>3.5	>3.5	>3.5	min 2.9 max. 3.5
1.4 Evaporative loss	CEC-L-40-A-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 15	≤ 15 for 10W-x or lower. ≤ 13 for others	≤ 13	≤ 13	≤ 13
1.5 Sulfated ash	ASTM D874		% m/m	≤ 1.3	≤ 1.8	≤ 1.5	≤ 1.6	≤ 1.6
				NOTE: The following sections apply to all sequences				
1.6 Sulfur			ppm m/m	Report				
1.7 Phosphorus			ppm m/m	Report				
1.8 Chlorine			ppm m/m	Report				
1.9 Oil / elastomer compatibility See Note (1)	CEC-L-39-T-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		RE1	Elastomer RE2-99	type RE3	RE4	AEM (VAMAC)
		Hardness DIDC	points	-1/+5	-5/+8	-25/+1	-5/+5	As per Daimler-Chrysler
		Tensile strength	%	-40/+10	-15/+18	-45/+10	-20/+10	
		Elongation at rupture	%	-50/+10	-35/+10	-20/+10	-50/+10	
		Volume variation	%	-1/+5	-7/+5	-1/+30	-5/+5	
1.10 Foaming tendency	ASTM D892 without option A	Tendency - stability	ml	Sequence I (24°C) 10 - nil Sequence II (94°C) 50 - nil Sequence III (24°C) 10 - nil				
1.11 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency - stability	ml	Sequence IV (150°C) 100 - nil				

(1) Use either complete DaimlerChrysler requirements (VDA 675301, 7 days +/- 2h, 4 materials (NBR: NBR34 DIN 53538 T3 (100 ºC +/- 2°C); FPM: AK6 (150 ºC +/- 2°C); ACM: E7503 (150 ºC +/- 2°C); AEM: D 8948/200.1 (150 ºC +/- 2°C)) + RE3 according to requirement 1.9 above, or complete requirements according to 1.9 above + DC requirements for AEM.

New CEC RE3 material and limits are to be developed and added to Sequences as soon as possible.

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				
				B1-02	**B2-98 Issue 2**	**B3-98 Issue 2**	**B4-02**	**B5-02**
2. ENGINE TESTS								
2.1 Ring sticking & Piston cleanliness	CEC L-46-T-93 (VW 1.6 TC D) (See Note 3)	Ring sticking Piston cleanliness	merit merit	≥ RL 148 ≥ RL 148	≥ RL 148 ≥ RL 148	≥ RL 148 ≥ RL 148	-------- --------	-------- --------
2.2 Medium temperature dispersivity	CEC-L-56-T-98) (XUD11BTE)	Absolute viscosity increase at 100°C and 3% soot (measurement with CEC L-83-A-97 method) Piston merit (5 elements) (average for 4 pistons)	mm^2/s merit	≤ 0.50 x RL197 result. ≥ (RL197 minus 6 pts.)	≤ 0.90 x RL197 result. ≥ (RL197 minus 6 pts)	≤ 0.50 x RL197 result. ≥ RL197	≤ 0.50 x RL197 result. ≥ RL197	≤ 0.50 x RL197 result. ≥ RL197
2.3 Wear, Viscosity stability & Oil consumption	CEC-L-51-A-98 (OM602A)	Cam wear. average Viscosity increase at 40°C Bore polishing Cylinder wear. Average Oil consumption	µm % % µm kg/test	≤ 50.0 ≤ 90 ≤7.0 ≤ 20.0 ≤ 10.0	≤ 50.0 ≤ 90 ≤7.0 ≤ 20.0 ≤ 10.0	≤ 50.0 ≤ 90 ≤7.0 ≤ 20.0 ≤ 10.0	≤ 50.0 ≤ 90 ≤7.0 ≤ 20.0 ≤ 10.0	≤ 50.0 ≤ 90 ≤7.0 ≤ 20.0 ≤ 10.0
2.4 DI diesel Piston cleanliness & Ring sticking	CEC-L-78-T-99 (VW DI)	Piston cleanliness Ring sticking (Rings 1 & 2) Average of all 8 rings Max. for any 1st ring Max. for any 2nd ring	merit ASF ASF ASF	----- ----- ----- -----	----- ----- ----- -----	----- ----- ----- -----	≥ RL206 minus 3 points ≤ 1.2 ≤ 2.5 ≤ 0.0	≥ RL206 ≤ 1.2 ≤ 2.5 ≤ 0.0
2.5 Fuel economy See Note (4)	CEC-L-54-T-96 (M111E)	Fuel economy improvement vs. Reference oil RL191 (15W-40)	%	≥ 2.5	--	--	--	≥ 2.5

(3) A passing result in the CEC L-78-T-99 test (VW DI) to the B4 requirements may be used in place of the CEC L-46-T-93 test.
(4) ACEA considers the CEC L-54-T-96 test the only valid comparator against which claims of lubricant fuel economy improvement should be made.

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

REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				ACEA: E2-96 Issue 4	**ACEA: E3-96 Issue 4**	**ACEA E4-99 Issue 2**	**ACEA E5-02**
1. LABORATORY TESTS							
1.1 Viscosity		SAE J300 Latest Active Issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC-L-14-A-93 (Bosch Injector)	Viscosity after 30 cycles measured at 100°C.	mm^2/s	xW-30 ≥ 9.0 xW-40 ≥ 12.0 xW-50 ≥ 15.0 no requirements for single grades		stay in grade	
1.3 Viscosity High Temperature High Shear Rate	CEC-L-36-A-97 (2nd Edition) (Ravenfield)	Viscosity at 150°C and 10^6 s^{-1} Shear rate	mPa.s	≥ 3.5			
1.4 Evaporative Loss	CEC-L-40-A-93 (Noack)	Max. weight loss after 1 h at 250°C	%	≤ 13			
1.5 Sulfated Ash	ASTM D874		% m/m	≤ 2.0			
1.6 Oil Elastomer Compatibility See Note (1)	CEC-L-39-T-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		RE1	Elastomer type RE2-99	RE3	RE4	AEM (VAMAC) As per Daimler-Chrysler
		Hardness DIDC	points	-1/+5	-5/+8	-25/+1	-5/+5	
		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	
1.7 Foaming Tendency	ASTM D892 without option A	Tendency – stability	ml ml ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil			
1.8 High temperature foaming tendency	ASTM D6082 High temp. Foam test	Tendency - stability	ml	Sequence IV (150°C) 200-50			
1.9 Oxidation	CEC-L-85-T-99 (PDSC)	Oxidation induction time	min				≥ 35
1.10 Corrosion	ASTM D 5968 (HTCBT)	Used oil lead conc. (Test temperature 135°C)	ppm				≤ 100

(1) Use either complete Daimler-Chrysler requirements (VDA 675301, 7 days +/-2h, 4 materials (NBR: NBR34 DIN 53538 T3 (100 ºC +/- 2°C); FPM: AK6 (150 ºC +/-2°C); ACM: E7503 (150 ºC +/-2°C); AEM: D 8948/200.1 (150 ºC +/- 2°C) + RE3 according to requirement 1.6 above, or complete requirements according to 1.6 above + DC requirements for AEM.

New CEC RE3 material and limits are to be developed and added to Sequences as soon as possible.

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

REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				ACEA: E2-96 Issue 4	**ACEA: E3-96 Issue 4**	**ACEA: E4-99 Issue 2**	**ACEA E5-02**
2. ENGINE TESTS							
2.1 Bore polishing / Piston cleanliness	CEC L-42-T-99 (OM364LA)	Bore polishing	%	≤ 3.5	≤ 1.0		
		Piston cleanliness	merit	≥ 40.0	≥ 45.0		
		Average Cylinder wear	µm	≤ 3.5	≤ 3.0		
		Sludge	merit	≥ 9.4	≥ 9.5		
		Oil consumption	kg/test	≤ 16.0	≤ 12.0		
2.2 Wear	CEC-L-51-A-97 (OM602A)	Cam wear	µm	≤ 50.0	≤ 50.0	≤ 50.0	≤ 50.0
		Viscosity increase at 40°C	%			≤ 90	≤ 90
		Bore polishing	%			≤ 7.0	≤ 7.0
		Cylinder wear	µm			≤ 20.0	≤ 20.0
		Oil consumption	kg/test			≤ 10	≤ 10
2.3 Soot in oil	ASTM D 5967 (Mack T-8E)	Test duration:	Hours			300	300
		Relative viscosity at				4.8% soot	4.8% soot
		1 test				2.1	2.1
		2 test average				2.2	2.2
		3 test average				2.3	2.3
	ASTM D4485 (Mack T-8)	Test duration	Hours		250	-	-
		Viscosity increase at			3.8% soot	3.8% soot	3.8% soot
		1 test	mm^2/s		≤ 11.5	≤ 11.5	≤ 11.5
		2 test average	mm^2/s		≤ 12.5	≤ 12.5	≤ 12.5
		3 test average	mm^2/s		≤ 13.0	≤ 13.0	≤ 13.0
		Filter plugging, Diff. pressure	kPa		≤ 138	≤ 138	≤ 138
		Oil consumption	g/kWh		≤ 0.304	≤ 0.304	≤ 0.304
2.4 Bore polishing Piston Cleanliness Turbocharger deposits	CEC L-52-T-97 (OM441LA)	Bore polishing	%			≤ 2.0	≤ 2.0
		Piston Cleanliness	merit			≥ 40.0	≥ 25.0
		Boost pressure loss at 400 hrs	%			≤ 4	≤ 4
		Oil consumption	kg/test			≤ 40	≤ 40

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REQUIREMENTS	TEST METHOD	PROPERTIES	UNIT	LIMITS			
				ACEA: E2-96 Issue 4	ACEA: E3-96 Issue 4	ACEA: E4-99 Issue 2	ACEA E5-02
2. ENGINE TESTS continued							
2.5. Soot induced wear (*)	ASTM RR: D-2-1440 (Cummins M11)	Rocker pad average weight loss at 4.5% soot 1 test	mg				≤ 6.5
		2 test average	mg				≤ 7.5
		3 test average	mg				≤ 8.0
		Oil filter diff.press EOT 1 test	kPa				≤ 79
		2 test average	kPa				≤ 93
		3 test average	kPa				≤ 100
		Engine sludge 1 test	merit				≥ 8.7
		2 test average	merit				≥ 8.6
		3 test average	merit				≥ 8.5
2.6. Wear (liner-ring-bearings) (**)	ASTM D 6483 (Mack T-9)	Avg.liner wear normalised to 1.75%soot 1 test	µm				≤ 25.4
		2 test average	µm				≤ 26.6
		3 test average	µm				≤ 27.1
		Average top ring weight loss 1 test	mg				≤ 100
		2 test average	mg				≤ 115
		3 test average	mg				≤ 130
		Used oil lead content increase	ppm				≤ 20
		Used oil lead content increase at 400-500 h	ppm				≤ 10

(*) The requirements for these characteristics may be met with a passing result on a Cummins M11 EGR test in an API CI-4 qualification.

(**) The requirements for these characteristics may be met with a passing result on a Mack T-10 test in an API CI-4 qualification.

ACEA members have identified a number of requirements for which tests are not currently available, but which are either under development or are desirable for inclusion in the next issue of these sequences.

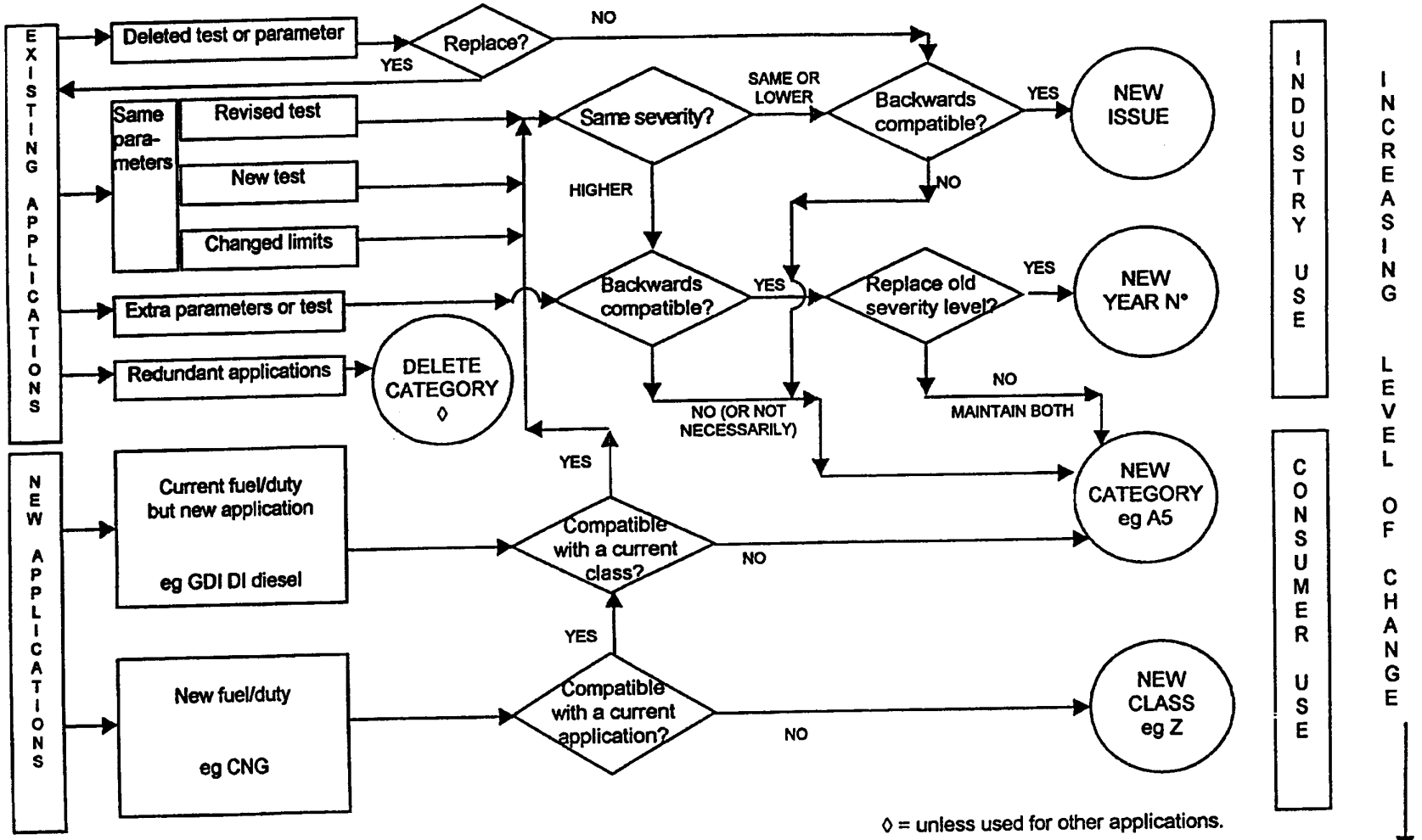
REQUIREMENTS	POTENTIAL TEST METHOD	PARAMETERS	APPLICABILITY
Corrosion	Ball Rust Test	<Grey scale value	All A and B Categories
Longevity of fuel economy benefit	See Note (5)		A1, A5, B1 & B5 Categories
EGR performance			E Categories
Fuel economy			E Categories
Exhaust aftertreatment system compatibility	i/. OPEST test	i/. Three way catalyst deactivation ii/. Diesel particulate filter pressure differential. iii/. Diesel oxidation catalyst deactivation	A, B and E categories
Wear			B Categories
Increased extended drain intervals			A and B categories

(5) CEC-L-54-T-96 is conducted on fresh oil. CEC-L-89-xx is currently being developed to show longevity of fuel economy benefit.

This list is not exhaustive.

ACEA

ACEA OIL SEQUENCES - ACEA DEVELOPMENT DECISION GUIDELINES



FOR MULTIPLE CHANGES THE PATH WITH GREATEST LEVEL OF CHANGE RULES